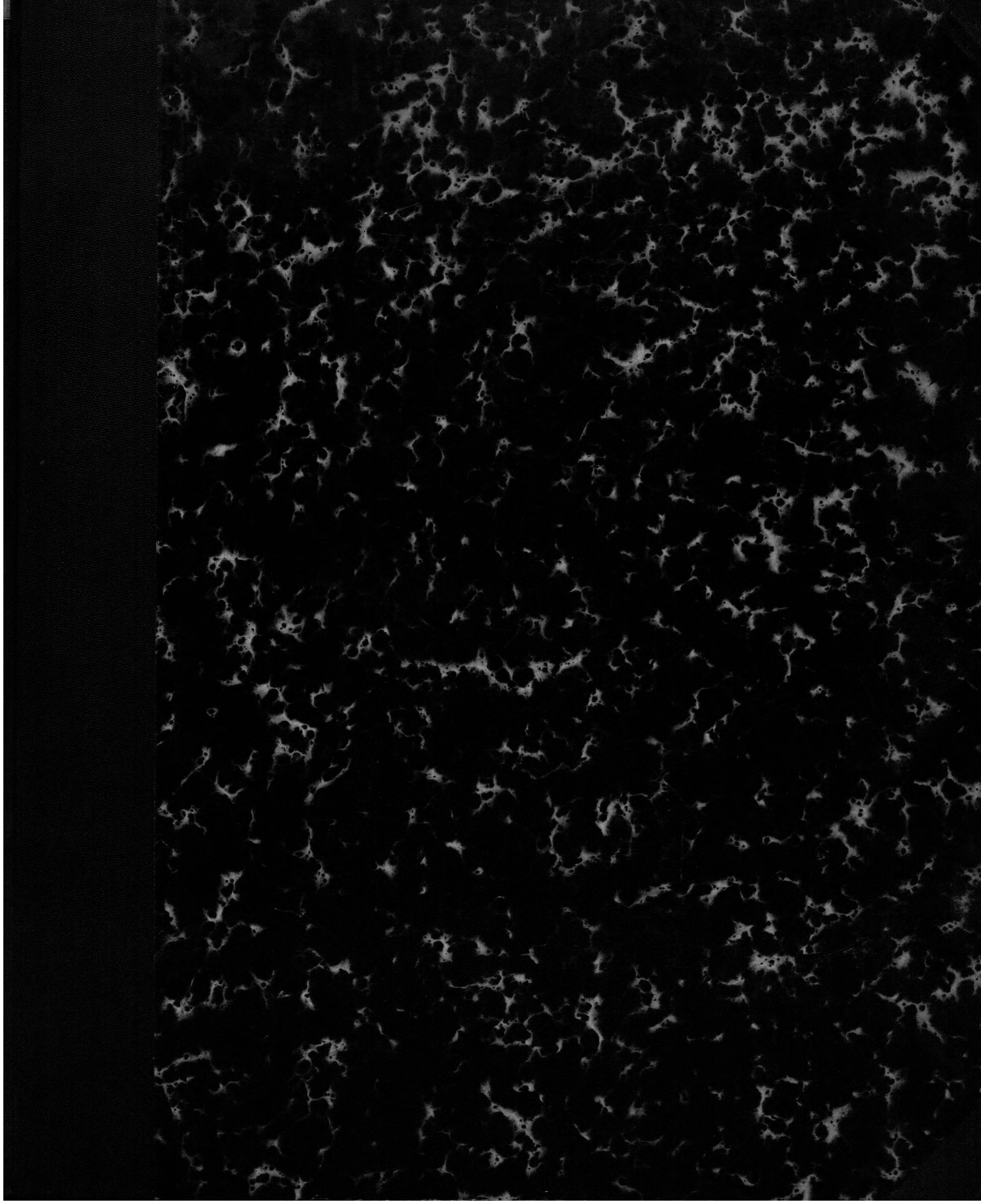
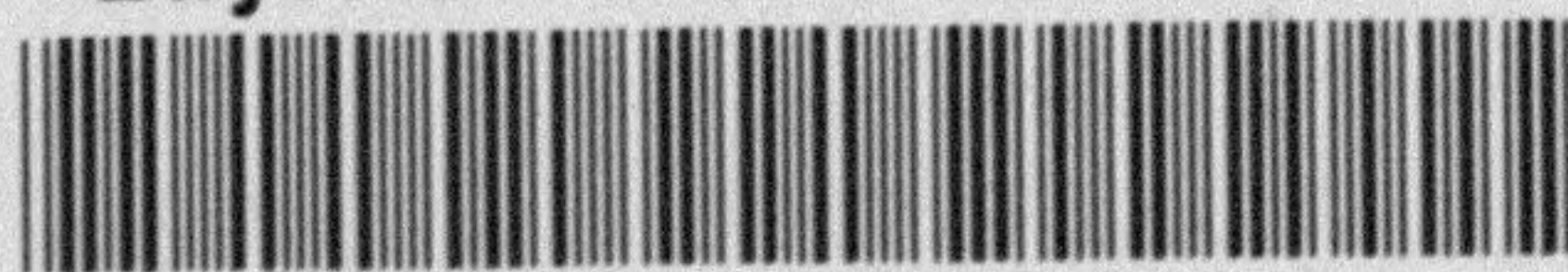




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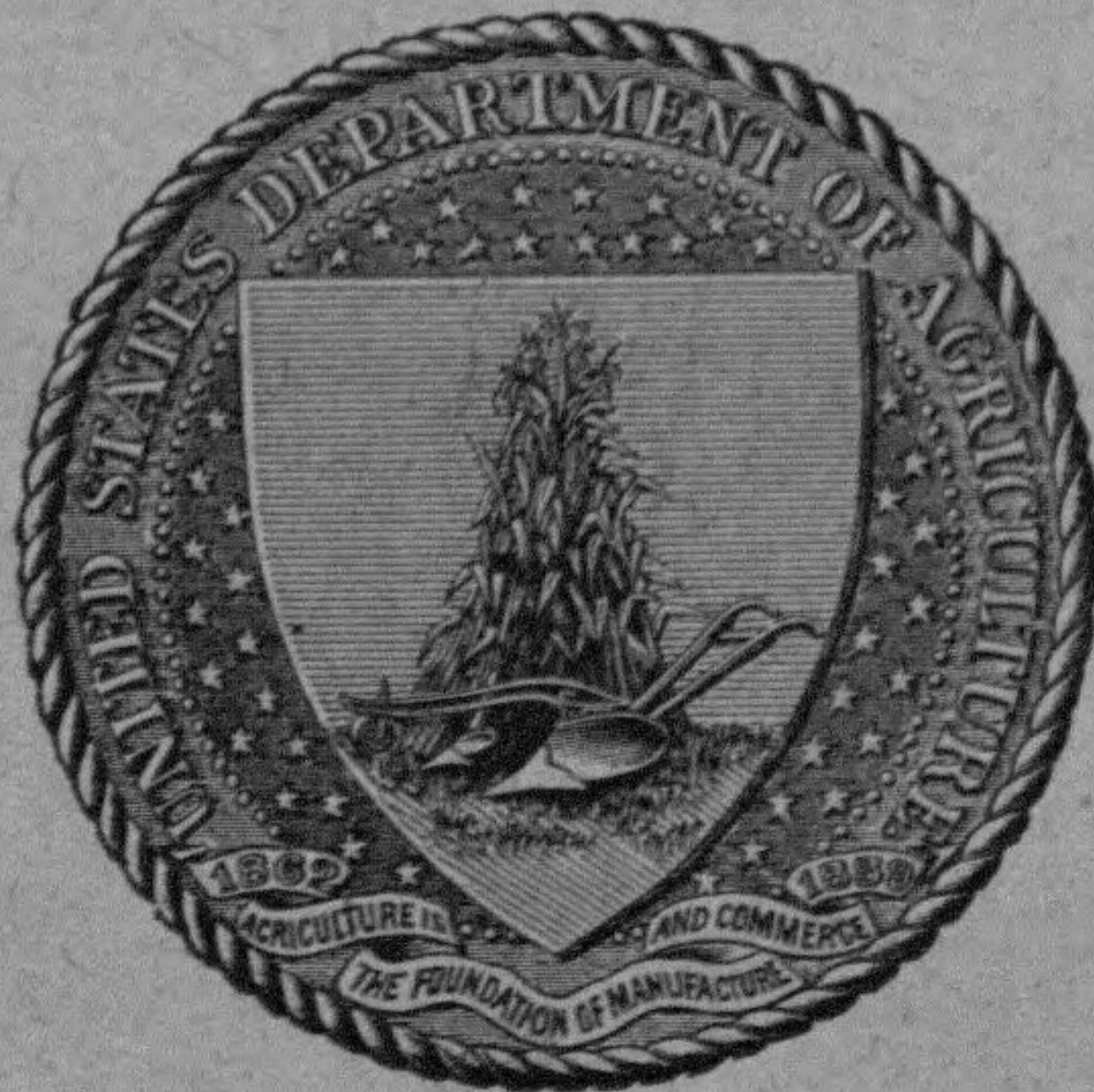
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DIVISION OF POMOLOGY.

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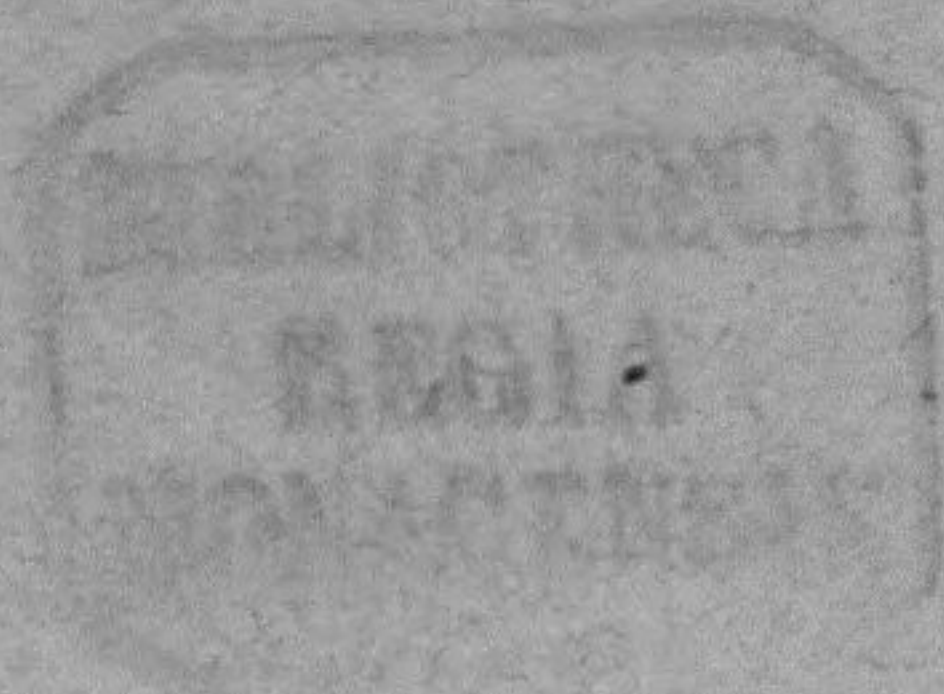
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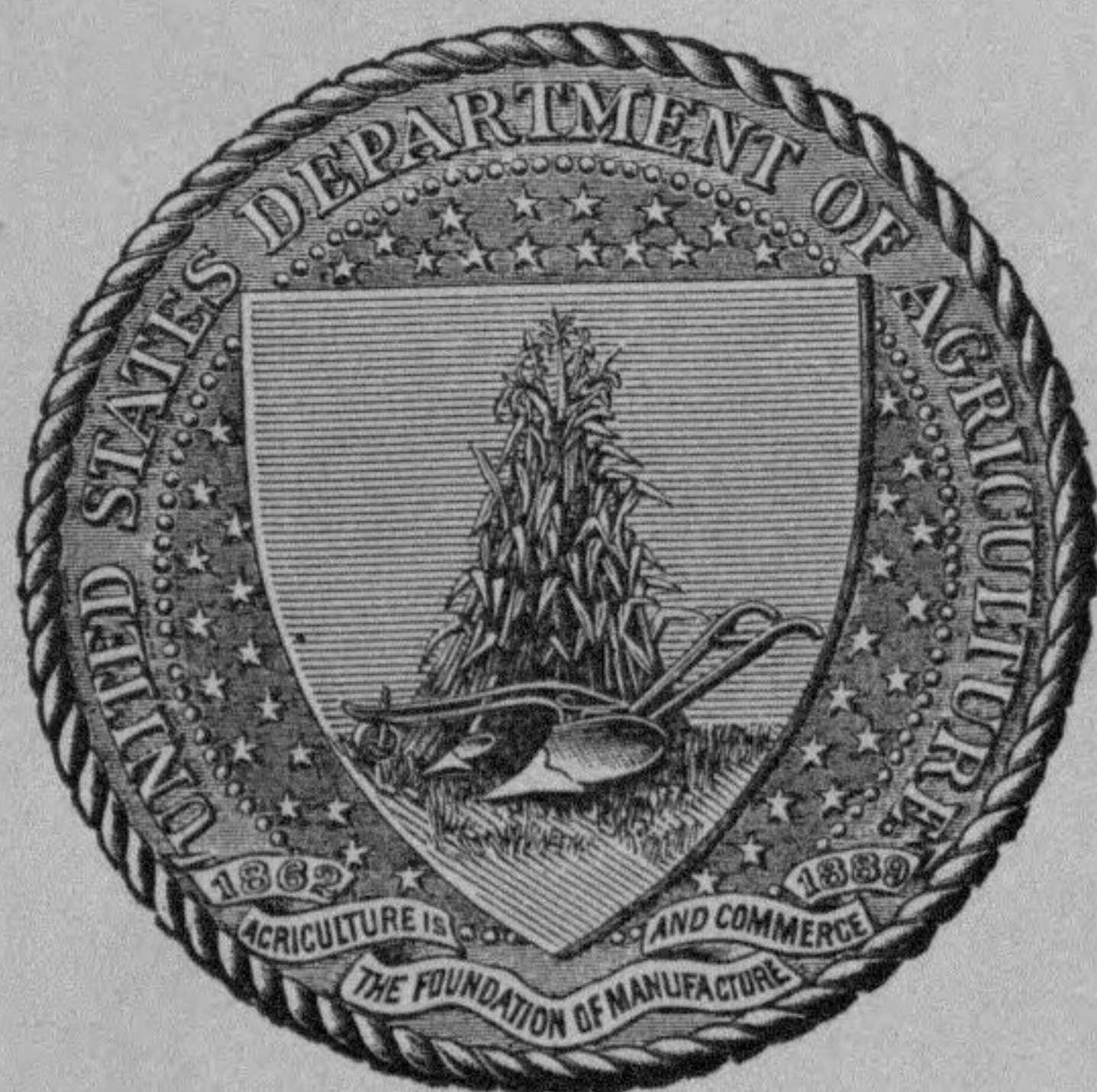
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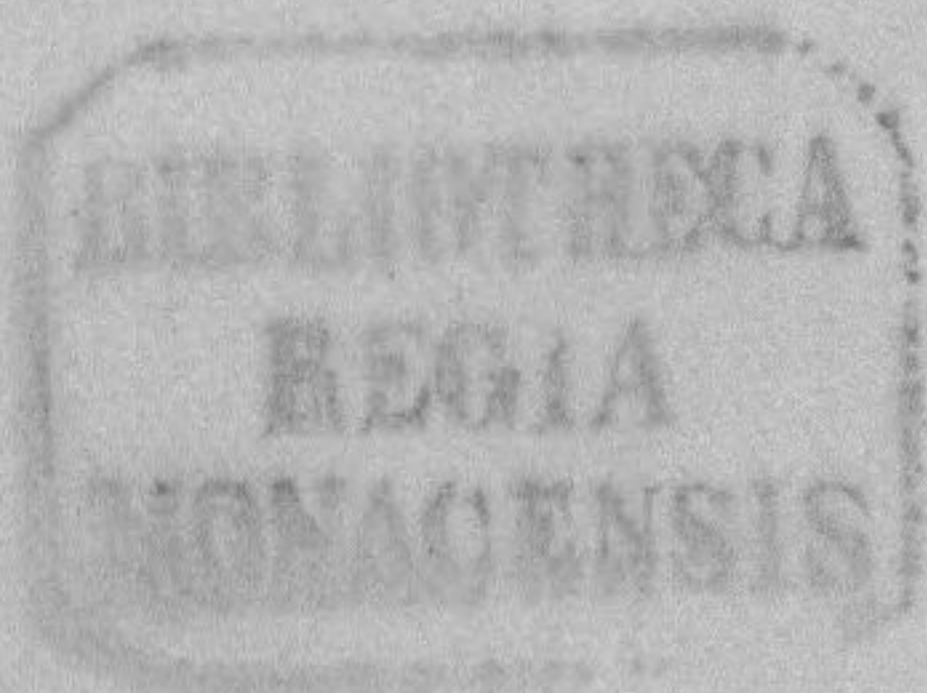
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1896.



LETTER OF TRANSMITTAL.

UNITED STATES DEPARTMENT OF AGRICULTURE,
DIVISION OF POMOLOGY,
Washington, D. C., October 1, 1895.

SIR: I have the honor to submit herewith for publication a special report on Nut Culture in the United States. This report is based upon replies by growers in all parts of the country to a circular of inquiry sent out in 1890 by my predecessor in office, Prof. H. E. Van Deman. These replies were carefully tabulated and compiled by Mr. W. P. Corsa, of this division, who has prepared the text of the report. The literature of the subject is limited, but such authorities as are available have been examined and, to some extent, quoted.

We are indebted to the numerous correspondents of the division, both in this and other countries, for many of the specimen nuts received for examination and illustration, as well as for information regarding the nut trees and methods of culture of their respective regions. Without their cordial and gratuitous assistance the report could not have been prepared with the means at our command.

The unavoidable delay in the publication of this report has afforded opportunity for the revision of the manuscript and the introduction of data based upon continued observation and experiment to the present date.

Very respectfully,

S. B. HEIGES,
Pomologist.

Hon. J. STERLING MORTON,
Secretary of Agriculture.

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NUT CULTURE IN THE UNITED STATES.

WILD AND CULTIVATED NUTS.

The culture of nut-bearing trees for their fruit in the United States has until recently been confined to narrow limits, both as regards the area devoted to their growth and the number of species brought under cultivation. This is due in part to the abundance of wild nuts, which in many localities have supplied the market demand, and in part to the fact that greater skill is necessary to produce superior nuts than is required in the culture of most other fruits.

Perhaps the chief cause that has operated to retard interest in this subject has been the impression that the man who plants nut trees does so for his successors rather than for himself. This, however, has not been the experience of the late W. R. Stuart with the pecan in Mississippi; A. T. Hatch with the almond in Solano County, Cal.; Russell Heath with the Persian walnut in Santa Barbara County, Cal.; Samuel C. Moon and H. M. Engle in Pennsylvania; and William Parry with the chestnut in New Jersey; nor of some others who have achieved success in nut culture after being well advanced in life. Such examples should inspire interest in young men to investigate this subject and to include nut culture in their systems of farming.

Ever since the colonization of America there have been some individual efforts and interest in the planting of nut-bearing trees near homes for nut production as well as shade. Chestnut, walnut, and hickory trees have been spared in clearing away the forests, and in succeeding years have yielded to their owners abundant crops of these wholesome products of the soil.

Doubtless to thousands of our citizens whose childhood was spent in the country reference to this subject will tinkle the bells of memory and call to mind pictures of home and youth in the halcyon days of long ago. Even now the supply of native nuts in our markets consists largely of wild nuts harvested by boys and girls who gather them for pleasure; but in many sections the nut harvest is a blessing direct from Nature's hand to the poor, and in others a source of profit to the well-to-do farmer.

The efforts to establish "orchards" of most of our wild nuts have not passed beyond the experimental stage. This treatise is therefore intended to encourage experimental work among growers, and to incite them to investigate the possibilities of their respective regions by planting and testing choice kinds that are likely to succeed. The development of this industry can not be dreamed out; it must be worked out. Not every man who plants nut-bearing trees will receive rich returns. No large investment in nut orchards should be made in any region until a careful determination has been made of the species best suited to its soil and climate. And even then the enterprise is a mere lottery unless trees of a productive variety are obtainable, the fruit of which will create by its desirable qualities a special demand for the product. The best guide in selecting both the species and the varieties for planting will commonly be the productiveness and quality of product of trees planted or growing naturally in the neighborhood. These seem so important that we can not forbear urging that in

localities where there are no fruiting specimens of the species that he contemplates growing, the planter first seek experience by planting a few trees rather than a large number.

The ordinary commercial grower will not be justified in incurring the expense of the experiment until he has a choice variety with which to begin. No seed can be depended upon to give a nut identical in character with the one planted. The variation in seedlings, due to cross fertilization and the inherent tendency to vary, is as marked in many kinds of nut trees as in other wild or little-cultivated fruits. If it is not safe to depend solely upon the planting of peach stones to produce orchards of trees bearing good peaches, is it not less safe to depend solely upon seedling nut trees in planting orchards that will take three times as long under ordinary conditions to reach bearing age? In view of the importance of this phase of the subject, a special effort has been made to determine in what particular, if any, the budding and grafting of nut trees differ from the budding and grafting of ordinary fruits. A discussion of general methods of propagation will be found, and under the head of each species requiring special treatment a summary is given of the experience of propagators who have done experimental work with trees of the species discussed.

NURSERY AND ORCHARD.

For stocks upon which to build an orchard or nursery seedlings of the same or of some closely allied species are necessary. Such seedlings may sometimes be obtained in the forests, but ordinarily they are cheaper and more satisfactory when grown under nursery treatment. In belief and practice leading growers do not agree as to the best method to be followed in establishing nut orchards. Some advise the growing of some species in the nursery rows until they begin to bear; some advocate leaving the trees in nursery rows but one, two, or three years; while others insist that the nuts should be planted where the trees are to remain, so that all transplanting may be avoided.

Between the extreme practices of leaving trees in the nursery rows until they come to fruitage and the planting of the germinating nut on the spot where the tree is intended to grow there is a broad field for experiment. Somewhere between these extremes the accepted practice of the future will probably be developed.

The advocates of the nursery period of long duration claim for their method (1) greater ease and less expense of cultivation of young trees in the nursery row than in the orchard; (2) less liability to injury of the trees during such cultivation by ordinary farm help; (3) increased facility of cropping the contemplated orchard site without the presence of small trees, and the consequent increased profit from such cropping; (4) a more uniform stand of orchard growth when the plantation first comes into bearing.

Those who advocate planting the nuts where the trees are to stand base their views mainly on the belief that it is necessary to retain the taproot system of the tree. They hold that when the natural deep-root system is retained the tree is more hardy and lives to a greater age than it would if its roots were shortened by transplanting. It has not been demonstrated by experiment, however, that within the ordinary life of a thrifty tree grown by either method there is any perceptible difference in the aggregate product of nuts.

It is commonly believed of all fruits that cultivation hastens and increases fruit bearing; also that checking limb or root growth within certain limits, as by pruning, will effect these results. It is known that fruits have not only been materially modified in size, color, and flavor by the influence of cultivation and an increased food supply, but that such influence also extends to the habit of growth of the roots and branches. Experiment alone can determine whether a severed taproot is to any extent a cause of earlier or greater fruitfulness of the tree; what effect this change of

root growth has upon the longevity of a tree unaffected by fruit bearing; and whether the modified root growth, sometimes noticed in transplanted trees, is due to transplantation or to cultivation and increased food supply, and to what extent it affects the fruitfulness of the tree.

If the nursery system of propagation is determined upon, it may in the case of some species enable the planter to secure trees of considerable size at planting time. But he will need to give some attention from year to year to the pruning of the taproot, or the trees at replanting time will be deficient in fibrous surface roots and possess only one, or at most a very few, deep-running roots with but few lateral branches. The practice of pinching the tip of the radicle when removing the nut from the germinating box to the nursery row, is claimed by some to aid materially in the production of surface roots, but it will not do to rely wholly upon this practice for success. It should be followed by the cutting of the taproot at the end of the first season's growth. To effect this have a careful man on each side of the nursery row push a long sharp spade into the earth under the tree so that the points of the spades will meet at such an angle beneath it as will save the most surface roots and sever the taproot. A very sharp thin-bladed tree digger might be used in some soils by careful workmen, but the roots must not be slivered, or "broomed," in cutting.

PROPAGATION.

Unless the trees are to be budded or grafted no nuts should be planted that have not been selected for superiority in size, flavor, or thinness of shell. They may be planted in the fall as soon as possible after they are ripe, but are safer if placed in sprouting beds or boxes and kept till early spring.

Plant in boxes of soil and cover with a mulch of leaves; the depth and moisture to be patterned as closely as possible after Nature's method in the forest. The object in using the box is to make easy the keeping of a record, and to prevent mice and moles from disturbing the nuts after they have sprouted in the spring. These boxes of embedded nuts should be settled in the earth to within two inches of their tops in some protected spot where pigs, squirrels, or fowls can not get at them. A liberal quantity of ashes should be mixed with the soil in the box to prevent damage from ants, for where ants have the run of a sprouting nut bed they play havoc with the kernels as soon as the shells have opened enough for them to enter. The surface of the soil in the box should be level with that of the ground outside. In the spring these nuts, when burst by the growing germ, are to be transplanted either to the nursery row or to the orchard site.

Where a large quantity of seed is to be handled, particularly in the case of the almond, stratification is resorted to, as practiced by nurserymen in propagating the peach. This consists in mixing the nuts in damp sawdust or sand either in a pit dug in well-drained soil or in boxes or bins built for the purpose in cellars. Here they are left till spring. Care is taken that the mass is uniformly moist, and an occasional mixing is advisable to keep it so. The object is to have the nuts gradually absorb sufficient moisture to insure the bursting of the shell by the swelling kernel. This usually occurs during the warm weather of spring; and the germinating seeds, which are easily freed from the sawdust or sand by using a sieve made of coarse wire netting, commonly go direct from the stratification beds to the location that has been prepared for their planting either in the nursery or the orchard.

Nuts that have become dry may, within reasonable limits, be quickened in germination by pouring warm (not boiling) water over them and leaving a few hours before planting.

Another method sometimes followed with success is thus described by the late D. B. Wier: "It is generally thought that nuts thoroughly dried will not grow. This is especially true of the American chestnut. Many years ago I experimented largely

with tree nuts, and especially with the American chestnut, and found that though very dry, after having been spread out on a shelf near a fire for months, such nuts, if placed in ice water and kept at a low temperature for three or four days and then placed in damp sand, would grow about as well as fresh nuts kept moist. By this plan I succeeded in starting the different species of chestnut, black and white walnuts, almonds, hazelnuts, and many species of acorns, etc., and have succeeded in sprouting them quite late in the spring. But it is necessary that the water be kept constantly cold until the nuts have absorbed enough to be saturated. This will take from one to two weeks for walnuts, peach stones, and other hard-shelled nuts."

A test of this method made at the Division of Pomology was partially successful. Pecans and Persian walnuts gave a fair percentage of success, but no chestnuts sprouted; few of the hazelnuts thus treated sprouted even after lying in the ground an entire year.

PLANTING.

Whatever advantage in theory may be secured by planting the nut where the tree is to stand, the prevailing practice in the United States is to start trees in the nursery rows and transplant them later to the orchard. To insure an even stand and good start the soil of the nursery should be as thoroughly prepared and as well enriched as for a garden crop. Planting should be done in rows not less than 4 feet apart if the trees are to remain longer than one year. The distance in the row and the depth of planting should vary according to the size of the tree and character of the seed. In general nuts should not be planted closer together than 8 inches nor covered deeper than $1\frac{1}{2}$ or 2 inches, though some of the slow-germinating walnuts and hickories may be safely planted deeper. If the nuts have sprouted before planting, the protruding radicle, which is the first evidence of growth, should be pointed downward in planting. If they are to be planted where the trees are to stand, the soil should be thoroughly prepared for a distance of several feet at least about the proposed site of the tree, and preferably over the whole area planted, if the land can be cultivated in ordinary hoed crops. Several nuts should be planted a few inches apart and with the same carefulness as in the nursery method, in order that there may be a choice of trees when the time comes to remove all but the one that is to be saved.

Cultivation of the young trees either in nursery or orchard should be thorough and careful, that they may be neither choked by hardened soil or weeds nor injured by the careless use of tools. It should not be continued later in the summer than is customary with young fruit trees in the same region, as injury from the winterkilling of immature wood may result.

BUDDING AND GRAFTING.

Some experienced propagators think it advantageous to transplant nut trees several times in the nursery rows before budding or grafting, while others report satisfactory results without such expense and delay.

The methods of bud propagation practiced on nut trees differ slightly from those commonly practiced by fruit growers, but the underlying principles are the same. The work is generally done while the trees stand in the nursery row, though there are many instances recorded of the successful top grafting in the orchard of some species and of the winter root grafting of others. With the exercise of care and good judgment there seems to be no reason why satisfactory results may not attend these methods of perpetuating improvements in many, if not all, nut-bearing species. Experience counts for as much here as elsewhere, and further experiment is necessary to determine the particular methods of budding and grafting that will succeed best with different species under different climatic and soil conditions.

SHIELD BUDDING.

This is the simplest and easiest method of bud propagation. It has been widely tested in the propagation of nut trees, but has failed except in the case of a few species, such as the almond, Persian walnut, black walnut, pecan, and chestnut. Of these the almond is the only one in which it is uniformly successful under ordinary conditions. In California the Persian walnut is sometimes successfully worked in this manner; in Florida the pecan, both on its own roots and on other species of hickory. In Ohio the black walnut has been successfully budded by using buds of the previous year on trees just starting into growth in spring. The buds in this case were retarded by being kept at a low temperature in an ice house until the stocks were in condition to bud.¹ The last-named modification of this method is worthy of further trial on other species.

Thomas Andrew Knight records² success in budding the Persian walnut by using the minute buds found at the base of the new growth. These buds were inserted in stocks grown in pots and held as nearly dormant as possible by being kept in "a shady situation under a north wall," until the buds on bearing trees were in condition to cut, in July. The stocks were then removed to a forcing house and immediately budded. He states that the ordinary large buds of the walnut thus inserted invariably failed, though inserted in the same stocks with the smaller ones.

FLUTE PUDDING.

It may be asserted, on the authority of leading horticulturists, that this method is often successful in the top-working of trees of considerable size when done by a careful operator, where the ordinary methods of budding and grafting have failed. The method is by no means new, and will be found illustrated in most of the popular works on tree propagation. It is thus described by J. L. Budd, of the Iowa Experiment Station, who recommends it: "Top-working the hickory or walnut or any common tree or shrub can be done by annular [flute] budding. June, when the bark slips easily, is the time. Take scions one-fourth to three-fourths of an inch in diameter; remove a ring of bark $1\frac{1}{2}$ inches to 2 inches long, bearing a good, strong bud; cut off a limb of the stock, leaving a stub, from which another similar ring of bark is removed. The ring from the scion is carefully split if necessary and substituted, taking care that it neatly fits the remaining bark of the stub, and that its edges when split are close enough to unite. Cover the whole with a paper sack tied below the wound and success is sure. Care is necessary that the parts to be united fit and are not bruised." This method is better adapted to the top-working of large trees than to the low budding of small seedlings in the nursery.

Annular budding.—For use on small trees in nursery (and it is applicable also to the working of small branches in the tops of large trees), a modification of flute budding is practiced. It is commonly called "ring" budding or "annular" budding. It differs from the former method only in the preparation of the stock for the reception of the bud. In ring, or annular, budding the top of the stock is not removed until after the bud has grown fast. The ring of bark is removed very carefully to avoid bruising the cambium layer, and a close fit is essential to success.

Both of these methods require careful wrapping of the ring of bark with soft yarn, raffia, or other flexible tying material to hold in place. In both methods it is important that a smooth round portion of the stock be selected for the operation. This is usually found near the base of the shoot. In top budding large trees it is often found necessary to prepare them for budding by cutting back during the previous season the branches to be budded. This causes them to throw out vigorous

¹ Report of Pomologist in Report of Secretary of Agriculture, 1890, page 417.

² Transactions Horticultural Society, III, page 133.

young shoots suitable for working. Such shoots are also produced where branches are cut back for grafting, and in case the grafting fails these are utilized for budding.

Loudon¹ expresses the opinion that either flute or ring budding immediately at the collars of the roots of the walnut, each tree being covered with a bell glass to retain moisture, is the method most likely to be successfully practiced in the climate of Great Britain. It would without doubt succeed in this country if given sufficient care and attention.

TOP GRAFTING.

Top grafting as commonly practiced succeeds with but few kinds of nut trees. In such as admit of its use great care in performing the operation is necessary. It fails on the hickories and walnuts except in favorable locations and in warm climates.

The pecan in Florida has been successfully worked by several methods of top-grafting, notably cleft, veneer, and side, but in the North it is almost impossible to secure a durable union of scion and stock by these methods.

Two kinds of top-working are described and illustrated below. They are the methods found most successful on the walnut in California. The well-known veneer and splice methods are practiced on the chestnut in the Eastern States and have given as good results as any other methods in the top-working of this tree. In all methods of grafting in which the scions are cut to the wedge form it is essential that but one scarf be cut through the pith. (See Cleft Sap-Grafting, fig. 2, f^1 , f^2 , f^3 .) All authorities on the propagation of nut trees agree in their testimony on this point.

PRONG GRAFTING.

B. M. Le Long reports very good success in grafting the walnut with the "prong" method, which he thus describes:² "In this method the prongs, or extremities of the branches, are used. Fig. 1, *a*, illustrates the scion, or prong, used and the method of

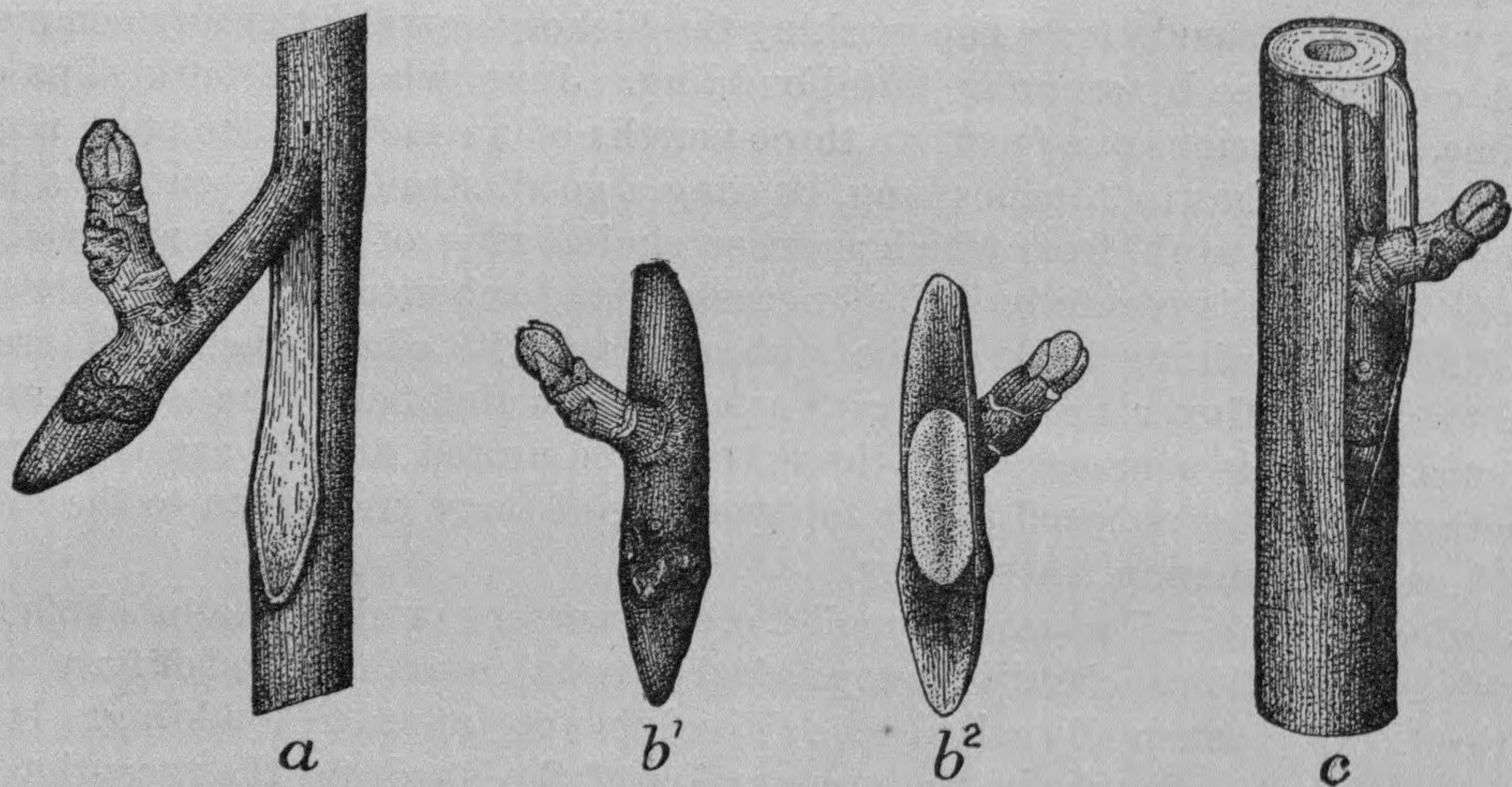


FIG. 1.—Prong grafting.

cutting it from the branch. The prong is cut as illustrated, and the wood in the prong (graft) is partly removed, being gouged out with the point of the budding knife. This is done to allow the inner bark of the bud to unite with the inner bark of the stock, which union would be prevented if the wood should be allowed to remain in the bud. After the wood in the bud has been partly removed, as shown in fig. 1, b^2 , the stock is cut off with a sharp saw and smoothed over with a knife, and the graft inserted, as shown in fig. 1, *c*, and tied tight; no less than 18-ply twine should be used. The cuts are waxed over with grafting wax. After the grafts have started, they should be

¹ Arboretum et Fruticetum Britannicum, Vol. II, page 1432.

² Pacific Rural Press, November 1, 1890.

examined, and if the twine is found to begin to cut into the stocks it is untied and tied over again; this will prevent further injury. The object of allowing the twine to remain a longer time is to prevent the cut bark from warping open by the action of the atmosphere, thus causing the graft to die." If grafting fails, annular budding may be resorted to. In that case the vigorous new shoots that push out below the attempted graft should be selected and the operation be performed in summer as in ordinary annular budding.

CLEFT SAP GRAFTING.

In top-working the walnut in California Felix Gillet states that common cleft-grafting does not succeed, but that cleft sap grafting succeeds. (Fig. 2, $d-f^3$.) If done early in the spring when the sap is commencing to flow it can be used on limbs as large as $3\frac{1}{2}$ inches in diameter. The stock is sawed off and smoothed as for ordinary cleft-grafting. Instead of making a single cleft through the center, two are made, one across the stub at each side of the center (fig. 2, $d e, d e$), the clefts thus being in

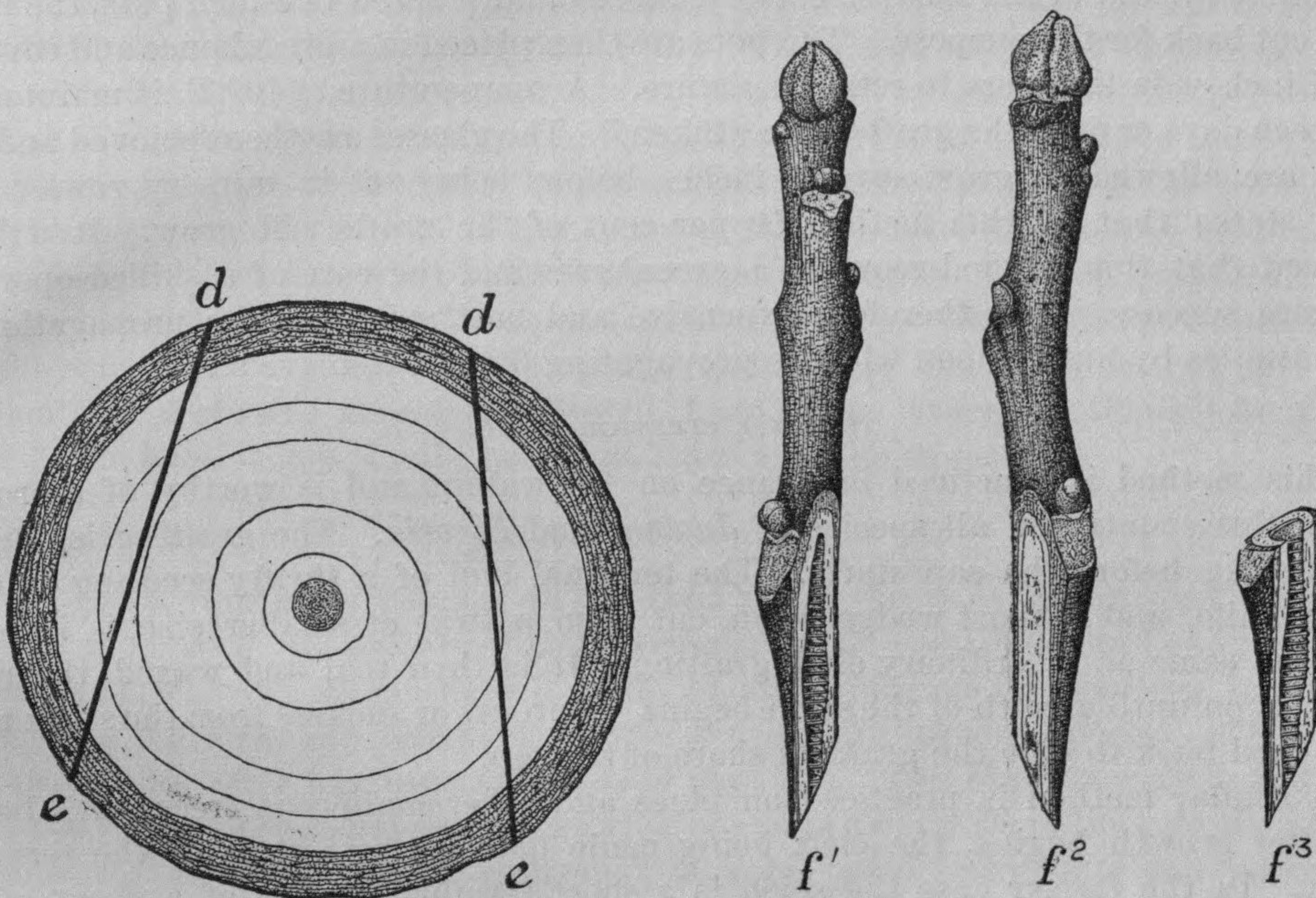


FIG. 2.—Cleft sap grafting.

sapwood instead of through the heartwood and pith. The scion is prepared as for ordinary cleft-grafting, except that the sloping cuts are so made that but one scarf exposes the pith (fig. 2, f^1, f^2, f^3). The figure, which is adapted from Mr. Gillet's illustration, is self-explanatory. After the insertion of the scions the cut surfaces are thoroughly waxed and the stock is well bound with cotton cloth to prevent it from opening and drying out.

CROWN GRAFTING.

This has been found to be the most successful plan for grafting most nut-bearing trees. It can be done by either the "whip," "cleft sap," or "veneer" methods, on seedlings from one-half inch to 4 inches in diameter, either in the nursery row or the orchard.

After removing the earth to the depth of 3 or 4 inches from about the base, the tree should be smoothly cut off about 2 inches below the ground line, or just above where the swelling of the root begins. On small trees, such as are less than 1 inch in diameter, either whip or veneer grafting is commonly practiced. On larger trees the cleft sap method (Fig. 2) is best. In all cases the stocks should be bound with waxed cloth or other tying material after the scions are inserted. Waxing

is unnecessary unless in loose, dry soil or during a dry season. Scions should not be less than 5 or 6 inches long, and those having a terminal bud are preferred. A ball of wet clay may be closely pressed about the wound, and over it the earth should be banked well to the top of the scion.

The best time for crown grafting is just as growth starts in the spring, but scions should be cut early and stored where they will remain entirely dormant, as in the sawdust of an ice house or in damp sand not exposed to the sun.

ROOT GRAFTING.

A few propagators report success with the pecan by the ordinary whip-graft method, as practiced on the apple, but in view of the numerous failures reported by others it can not be recommended for general use. Felix Gillet, of Nevada City, Cal., reports that the only successful method of root grafting the Persian walnut is by what he terms "hothouse grafting." In this method dormant 1-year-old seedlings, which have been stored in sand in the cellar, are cleft grafted with scions stored in a similar way, and of the same size as the stocks and planted in 3-inch pots, the roots being cut back for the purpose. The pots are then placed in a greenhouse and covered with 7-inch soda tumblers to retain moisture. A temperature of 70° F. is maintained for fifteen days or until the grafts have "taken." The glasses are then removed and the grafts are allowed to grow several inches before being set in nursery rows. Mr. Gillet states that by this method 50 per cent of the grafts will grow. It will be observed that this method requires a greenhouse and the care of a skilled operator to insure success. It is therefore expensive and best suited to the propagation of rare varieties by nurserymen who are propagating on an extensive scale.

TERMINAL CLEFT GRAFTING.

This method is practiced in France on the walnut and is worthy of thorough trial in this country on all species of *Juglans* and *Hicoria*. The grafting is done in early spring before the sap starts. The terminal bud of a thrifty seedling is cleft with a knife, and a short wedge scion, cut from a twig of smaller size, is inserted much the same as in ordinary cleft grafting. It is then tied and waxed, the band being left on until growth of the scion begins. Sprouts or suckers from the stock must be pinched back to give the graft its share of the sap.

A similar method is practiced on pines and other coniferous trees, both before and after growth begins, the cleft being made between two buds of the terminal cluster. In the former case the scion is a short terminal section of a shoot of the previous year. It must be carefully tied and waxed and should be covered by a paper bag tied on to protect from the sun and wind. The stouter shoots of the upper whorl on the stock should be cut back to half their length and the slender ones bent downward. Aside from this the stock should not be pruned at time of grafting. Young trees are the best subjects for the operation. The growing grafts require staking for a year or two until the scion and stock are firmly knit together.

In some parts of France the operation is successfully performed later in the season when the stock and scion are passing from the herbaceous to the woody state and possess sufficient consistency to allow it.

PLASTIC GRAFTING WAX.

A good grafting wax is indispensable in the propagation of nut trees. Such can be made by melting together the following:

	Pounds.
Linseed oil or tallow.....	1
Resin.....	6
Beeswax.....	1

Pour the mass into a tub or bucket of water to cool, and knead it into balls of suitable size to handle.

LIQUID GRAFTING WAX.

The following liquid wax is one of the best in use. It is ready at all times of the year to cover the wounds on trees, and it is very serviceable in grafting. Applied with a varnish brush, the work is quickly and thoroughly done:

Melt 1 pound of common resin over a gentle fire; add to it 1 ounce of beef tallow. Stir it well. Take from the fire, let it cool a little, then stir into it a tablespoonful of spirits of turpentine and 7 ounces of 95 per cent alcohol. If the alcohol cools the mass very rapidly it may be necessary to put it on the fire once more, stirring constantly. The utmost care must be used to prevent the alcohol from igniting. To avoid danger, remove the vessel from the fire when the lumps that have been formed begin to melt. This must be repeated until the whole mass is converted into a homogeneous liquid like thick sirup.

TRANSPLANTING.

Having had much experience in setting out nut trees and evergreens, the writer is convinced that the work can be safely done in the following manner: Dig a trench of sufficient depth to get below the surface roots on either side of the nursery row, at such a distance from the trees as will save most of the surface roots. It will be found that notwithstanding the pinching off of the radicle and the later cutting of the taproot with the spade, as previously noted, there will be occasional deep-growing roots that should be saved. These should be smoothly cut at a depth of 2 or 3 feet. Where practicable, the trees should be taken up only so fast as they can be promptly reset in freshly prepared holes. If this is not possible, the roots should be constantly shielded from the sun and wind until the trees are replanted. When removed from the nursery row the roots should be puddled in thin clay. The method of setting is much the same as for the apple or the peach, the surface soil being thrown into the hole about the roots and thoroughly firmed down, then covered by the soil from the bottom of the hole, which should be left as loose and fine as possible.

IN THE ORCHARD.

From the sprouting of the nut to the time when the fruit is harvested there is much necessary care and culture that is common to all species of nut-bearing trees. In the orchard varying distances will be found advantageous for planting, based on differences in the sizes and habits of growth of trees of different species. The most widely prevailing error has been in planting too close. The Persian walnut and the almond make no more protest to the growing of crops among them than do the apple and peach. Perhaps the same statement may be made concerning the imported chestnuts, but many propagators of the American chestnut and the pecan insist that these do best without cultivation, and of course without other crops in their midst. H. M. Engle, of Marietta, Pa., thinks that after a chestnut orchard has attained bearing age it should be sown to grass and pastured with sheep to enrich the land. While it is questionable economy to tax the land for the production of other crops, the evidence now at hand does not justify the conclusion that ordinary cultivation is injurious to nut trees, and in the case of the almond it is commonly necessary for the production of profitable crops.

LACK OF FRUITFULNESS.

This may become the cause of serious complaint when a general effort is made to cultivate nuts for market. There is great variation in the fruitfulness of individual trees of the same species of most nut-bearing trees, even when their environments are similar. Most species of nut trees are monœcious, or bisexual—that is, the flowers of both sexes are on a single tree. But exceptions have been noted by many observers of supposed diœcious, or unisexual, individuals—that is, having the flowers of the two sexes on different trees. In such case trees of both sexes must be planted in close proximity to secure crops of fruit. We suspect that barrenness will more frequently

be found to be due to the different dates of blooming of the flowers of the two sexes, or to a deficiency in the number of male flowers, or a lack of potency in the pollen produced by them.

There is a lack of accurate data on the comparative season of blooming of individual trees and varieties of the leading species. Until more exact information can be had upon this subject it will be impossible to lay down definite rules to govern the commercial planter in this regard. It may be said in a general way that most cases of lack of fruitfulness of nut-bearing trees in regions where the trees make a thrifty growth seem to be due to two causes: (1) The untimely blooming of the male, or staminate, blossoms (on the Persian walnut they are frequently more than two weeks earlier than the pistillate ones); (2) to a deficiency in the amount or potency of their pollen. This deficiency may be due to an actual deficiency in the number of staminate buds found, as on young trees; to the destruction or weakening of the staminate buds by the cold of winter; to the washing away of pollen by heavy or long-continued rains at blooming time; or, as has been long believed by California almond growers, to a lack of potency of the pollen of a variety upon its own pistils.

Though the exact causes of the lack of fruitfulness have not been demonstrated in all cases, precautions which have been found to insure fruitfulness in many localities may be taken. These consist mainly in the mixing of the varieties planted, as with the almond, or of planting trees of other allied species in close proximity, as in the case of the walnuts. The object is to provide a continuous supply of pollen during the whole blooming period, and thus insure the pollination of the pistillate flowers. With a few trees this could doubtless be accomplished by tying branches of staminate blossoms secured from other trees, in the tops of the trees when in bloom. This practice is common in England, in the case of the hazel, where branches of staminate catkins secured from wild trees are often depended on to supply pollen deficiencies in the cultivated varieties.¹

With other nuts the record of experiment is wanting, and trial alone can determine whether choice varieties will be benefited by the close proximity of trees of allied species possessing greater hardiness and virility, or producing their pollen at a more opportune time.

HARVESTING.

The gathering of Persian walnuts, butternuts, and perhaps some of the other species for making pickles, catsup, or other culinary products, is done when the fruit is about half mature or when the shell is soft enough to yield to the influence of cooking. The proper stage can be determined by piercing the nut with a needle, a certain degree of hardness being desired.

Nuts mature on individual trees with as much irregularity of season as do most other fruits. Contrary to common belief, the frost that precedes the opening of the bur of the chestnut or of the hull of the hickory does not ripen the nut. It has no more to do with it than it has with the maturing of a winter apple that hangs on its tree at the same time. The frost may cause all the nuts to fall to the ground at once by checking the growth of the tree; this, occurring about the time that the nuts mature, precedes the opening of the bur or hull. A check in the circulation of sap through the outside of the bur or hull causes the outer surface to dry very rapidly, while the inner surface next the full-grown nuts remains more or less moist. The natural result is a shrinking of the outside of the involucre and the consequent separation of the parts, thus liberating the nuts.

Varieties differ several weeks in the time of ripening under apparently identical conditions, and specimens on the same tree vary in time of ripening, quite as much as do apples or pears. It is a matter of considerable importance in harvesting that trees which mature their fruit at the same time stand in proximity to each other, as the

¹ Arboretum et Fruticetum, Vol. III, page 2027.

expense of gathering the nut is thereby materially reduced. This can only be secured with any degree of certainty by planting blocks or rows of grafted or budded trees. If all fallen leaves and other hindrances are kept removed from beneath the trees at harvest time the work of gathering the nuts is facilitated. F. A. Swinden, of Brownwood, Tex., a prominent pecan planter, announces his intention of using a street sweeper which will gather the nuts into windrows, after which they will be gathered up and run through a machine for sorting and cleaning. But to what extent machinery may be profitably used in harvesting or preparing nuts for market is yet an unsettled question.

MARKETING.

At the present time the country store is the medium through which much of the wild-nut product finds its way to the city market. The storekeeper puts into barrels or boxes his weekly accumulation of nuts, often taken in exchange for goods, and consigns them to a commission merchant or wholesale dealer in the city. When stock is scarce, as is generally the case at the beginning of the season, the commission men are able to return much better figures for consignments than after every merchant has stock to offer. Hence, other things being equal, the early nut of its kind brings most to the producer, both because of its superior freshness and of the scarcity of new stock in the market. When the crop of wild nuts is large, as is sometimes the case with the hickory in the central Western States, dealers scour the country and buy them up in car-load lots for shipment to the cities. Undoubtedly with nuts, as with other fruits, when the quantity is large enough in one place to attract many buyers, competition among purchasers will raise the price. If a community of producers will unite on ordinary business principles, and assort and grade the nuts to recognized standards, still higher prices may be obtained. Close grading, honest packing, and auction sales at the place of production combine the points in marketing best calculated to effect the prompt and wide distribution of horticultural products and will probably yield the most satisfactory returns to the producer.

THE ALMOND.*

(*Amygdalus communis* L.)

Of our introduced nut-bearing trees, perhaps none has occasioned more disappointment among planters in the United States than the almond. It has been said that it will grow wherever the peach will thrive. So far as the growth of the tree and the production of blossoms are concerned this is to some extent true; but in fruit production the valuable varieties of the almond fail in most of our Eastern peach districts, and but little attempt is now made by growers outside of California to produce this nut. Some forty years ago a large importation of soft-shelled almonds was made by the Commissioner of Patents for distribution among fruit growers. Both nuts and trees were widely distributed to growers in the Southern and Middle States. Downing, like other pomologists of his day, was hopeful of the results of their introduction, and said:¹ "There is no apparent reason why the culture of the almond should not be pursued to a profitable extent in the warm climate of the Southern States. Especially in the valleys of the Ohio and Tennessee it would be likely to succeed admirably."

*AMERICAN ALMOND. Synonym: *Desert plum*. (*Amygdalus Andersonii* Greene.)—This almond is a native of America, and, though of no present pomological value, seems deserving of mention in this place. It is quite common among the rocky hills of southern California which inclose the Colorado desert. It is a low, bushy shrub, seldom attaining to the height of a man. It blooms there in February, with abundance of rose-red blossoms; the fruit is a small, velvety drupe, scarcely more than half an inch long, which, when ripe, divests itself of its thin, fleshy, external coat, much like the common almond, and exposes a small, nearly smooth nut. So far as we are aware, little effort has yet been made to cultivate it.

¹ Fruits and Fruit Trees of America.

As regards the production of nuts, these efforts seem to have resulted in failure, as all reports from those sections indicate that the blossoms of the almond, except of the worthless, hard-shelled variety, rarely escape spring frosts. The early blooming habit is the weak point in the almond and is a trait that has not been overcome by our Eastern pomologists. On the Pacific Slope also there was for a time widespread failure among almond growers, probably due to the same cause, but varieties recently originated and introduced there have proved reasonably regular in fruiting and have made almond growing exceedingly profitable in some small areas. The history of the growth of the industry in California is of interest, as an illustration of the progress that has been made in this line of horticultural work. According to Wickson,¹ the importation of European varieties began at an early date, a number of them having been planted prior to 1853.

They proved to be irregular bearers, though making a vigorous growth of wood. The importation and trial of varieties was continued, and some were eventually found that succeeded in a few localities, though they failed in others. From this it was concluded that the question of locality was all important, and the relative value of varieties was to some extent lost sight of. Some twenty years of experience resulted only in establishing the fact that in a few scattered localities occasional profitable crops of almonds could be produced. These served to keep alive the interest in almond culture and to stimulate efforts to extend it.

In 1878 A. T. Hatch, of Suisun, Cal., planted over 2,000 seedlings of the bitter almond, of which he budded all but about 300 trees. The fruit of these seedlings varied materially, and Mr. Hatch exhibited specimens of many of them at the New Orleans Exposition in 1885 and at the Sacramento Citrus Fair in 1886. At both of these exhibitions the collections attracted much attention, and Mr. Hatch was encouraged to propagate from the 192 varieties shown four that were selected for their distinctive and desirable qualities, namely: "IXL," "Ne Plus Ultra," "Nonpareil," and "La Prima." Since then Mr. Hatch and other propagators have found occasion to say many good words for later seedlings, as will be noted in the list of varieties given in this report. With the introduction of these varieties, almond planting again increased in California, and is now being tried in portions of Utah and Arizona with some degree of success.

The California crop in 1891 was estimated at 1,000,000 pounds, and it is stated by the State board of trade that the crop netted the growers more per pound than the price of the imported article, because of its superior quality. In that year the growers realized in the New York market² 22½ cents per pound for "paper-shell," 16 cents for "soft-shell," and 12 cents for "hard-shell" varieties.³

The total yield in successive years is stated by N. P. Chipman to have been as follows:

Yield of almonds in California from 1885 to 1892.

Year.	Pounds.	Year.	Pounds.
1885.....	1,050,000	1889.....	450,000
1886.....	600,000	1890.....	198,067
1887.....	500,000	1891.....	572,000
1888.....	450,000	1892.....	600,000

The importation of almonds, however, continues to more than keep pace with increased production. In 1855, according to the report of the Commissioner of Patents, almonds to a value of \$250,000 were imported, while in 1891 the importation had increased to 7,497,193 pounds, valued at \$989,966, and in 1892, 6,371,015 pounds,

¹ California Fruits, page 491.

² California State Board of Horticulture Report, 1891, page 86.

³ Not the hard-shell almond of the Eastern States.

valued at \$995,764. It will thus be seen that the production of almonds in this country does not yet exceed one-tenth of the quantity consumed.

CULTURE.

The essential factors of successful almond culture in California, as judged from our reports, would seem to be in their order of relative importance: Trustworthy varieties, suitable climate with proper slope or exposure, well-drained soil, and good culture.

Selection of varieties.—For profit the varieties planted should be reliable annual croppers under normal climatic conditions. They should hull easily, and should have clean, thin, soft shells, with smooth, bright, plump kernels. Nuts with long single kernels are preferred to those with double or triple ones by confectioners, whose purchases of these nuts have a marked effect on the market demand and price. They pay most for nuts with perfectly smooth, plump kernels, the size of the nut being of secondary importance. It is for this reason that the old Languedoc variety is less sought for in the markets than the newer California sorts.

Climate and exposure.—After widespread trial of the Languedoc and other old varieties it has been found that they only succeed in the mild climate of Sonoma, Solano, Alameda, and Santa Clara counties, far enough removed from salt water to be out of the fog belt and on bench or hillside situations, avoiding low lands and small valleys. This region can be considered as possessing the best climate for the almond yet found in this country. The fact that the newer varieties are found to succeed over a much wider range, including orchard sites where the old varieties have utterly failed, and extending to portions of Arizona, Utah, Nevada, New Mexico, and southwestern Texas, indicates that the range of probable profitable growth of the almond is much broader than has been for some time supposed.

In some sections a northern exposure or a table-land is preferred, and a southern or southeastern exposure is to be avoided, on account of the earlier blooming in the latter locations and consequent danger from spring frosts. Many growers, however, in reporting on this point, regard it as of little importance if proper varieties are planted.

Soil.—The soil should be light, warm, and well drained, the majority of growers preferring sand or gravel, though a few reports indicate good results on adobe, clay, and black waxy land. The almond grows native in Syria and northern Africa in very dry and stony locations, and is perhaps capable of enduring greater drought than any other of our cultivated fruit trees. But large and profitable crops are only secured from orchards on good soils. In a dry, warm climate, where water for irrigation is abundant, the yield from trees planted on black loam will be double that of trees on dry soil.

PROPAGATION.

The almond is mainly propagated by budding on seedling bitter almond stocks, though peach stocks are sometimes used. The apricot is condemned as a stock by most growers because of its imperfect union with the scion. The method of treating seed for planting is by ordinary stratification (see p. 11) either in sand or sawdust.

Ordinary nursery culture suffices, and shield budding is found satisfactory, the process being identical with that used on the peach. The most uniform stand of trees is secured by budding close to the ground. The northwest side of the stock is preferred for the insertion of the bud because less exposed to the sun's rays.

THE ORCHARD.

Trees should be removed from nursery to orchard at the earliest practicable age. Mr. Hatch reports his best success to be with dormant buds, although greater care is necessary with these than with trees that are one year old from the bud when trans-

planted. Before planting the trees the land should be well plowed and harrowed as for a hoed crop. Trees should be at least 24 feet apart each way on strong land. The rows may be lined out to a moderate depth with a two-horse plow, the intersections where the trees are to be set being determined by running cross furrows just ahead of the planting in order that the soil may be freshly turned when the trees are planted. It is a safe rule to set the trees about 1 inch deeper than they stood in the nursery. If dormant buds are planted the ground should not be filled in above the bud until it has grown to the height of a few inches. In all cases the roots should be well spread and fine surface soil should be well distributed between and above them and be securely firmed down to prevent drying out. The orchard culture needs to be thorough for the best results, but should be shallow close to newly set trees as well as in older orchards. Carelessness in regard to this important point often causes irregular and broken orchards. The orchard rows should be perfectly straight and at equal distances apart, as time is thereby saved in cultivating the orchard, and much accidental injury to the trees avoided.

Pruning at planting time is similar to that of the peach, the tree being cut back to a straight stem and the side branches to a single bud. Webster Treat cuts back his transplanted trees to 1 foot from the ground and forms the head of three branches grown from that point. This secures a larger proportion of bearing wood and tends to keep it nearer the ground.

Never shorten in as with the peach and apricot, for the almond, like the prune, bears most of its fruit on the long, slender outer branches and the short fruit spurs on the inside of the tree. These inside twigs will not die out as in the peach and apricot, but live and get more stubby and strong, bearing almonds every year. During the first three years enough pruning is done to shape the trees, and afterwards only to remove objectionable branches.

Summer pruning is to be avoided.

It has been found true with the Languedoc, and is suspected in the case of some other varieties, that the fruitfulness is much increased by planting intermingled varieties, so as to secure an abundance of pollen at the proper time. Planters will do well to bear this fact in mind in planting orchards.

AT FRUITING AGE.

The almond comes into bearing at from two to four years from budding, or at about the same age as the peach, and reaches mature fruitage at from seven to ten years old. The yield varies much, depending upon location, season, age of trees, and varieties. At Colusa, Cal., 2,000 trees of mature age are reported to have produced in 1886 for Alfred M. Newland, 24,000 pounds of hulled nuts, an average of 12 pounds per tree. From one tree he gathered 76 pounds. In 1890 this same orchard averaged 5 pounds per tree. The nuts begin to ripen about the middle of August in that latitude. J. J. Leeson, of Socorro, N. Mex., states that he harvested from one tree, in 1889, 420 pounds ready for market. A. T. Hatch, of Suisun, Cal., reports an average yield of from 20 to 30 pounds per tree; Ellwood Cooper, of Santa Barbara, Cal., writes: "Ten pounds [per tree] is an excellent crop on the coast; sometimes, of course, it will bear 40 or 50 pounds, but if the whole average 5 pounds it is a good crop."

PREPARATION FOR MARKET.

HARVESTING.

Gathering the nuts by hand is very tedious work, and is only practiced while the trees are very small. Generally the harvesting is done when somewhat more than half the nuts have burst their hulls; a sheet or canvass is spread beneath the tree, and on this the nuts fall when the tree is shaken.

A push cart, with an adjustable awning made like an inverted umbrella that would surround the tree and catch the falling nuts and funnel them into the cart, would be an improvement on this method of harvesting. At any rate, as suggested on page 19, there is room for inventive skill to simplify and cheapen the harvesting of nuts.

HULLING.

Some varieties in certain localities are found to burst the hulls on the trees so nearly at one time that they may be accounted self-hulling. These need no bleaching, as they are not discolored by unequal exposure to the hot weather. In most sections the hulls adhere to a considerable portion of the nuts, necessitating their forcible removal. In a small way these are removed by hand or by improvised rubbing machines, such as rotary churns, etc. Wickson thus describes a new hulling machine made in Alameda County:¹ "It consists of a grooved iron roller and a set of bars arranged with reference to the roller as the concave is to the cylinder of a threshing machine. Each of these bars is supported behind by a spring at each end, so that each works independently of the other and yields a little if an extra large nut strikes it. The machine runs by a hand crank, and requires but little effort to hull a sack in two or three minutes."

Webster Treat says: "When the necessity comes for the invention of an almond hulling and separating machine, and that will be soon, for California can grow almonds to a greater profit than anything else, there will no doubt be invented a machine that will hull and separate the almonds from the mass of hulls, which will greatly cheapen the preparing of the crop. It costs nearly 2 cents per pound to gather, hull, and bleach the almonds with our crude appliances for hulling and separating, wherein the greatest expense comes, but with a good huller and separator this could be reduced to half a cent per pound."

DRYING.

After the nuts are separated from the hulls they are placed on trays and dried in the sun or dry-house for a few days.

BLEACHING.

When dry enough to avoid molding, the nuts are bleached by being lightly sprinkled with water and exposed to the fumes of burning sulphur for about seven minutes. A bleaching house is thus described by Mr. Treat: "My bleaching house is boarded with tongued-and-grooved lumber inside and out, and roofed with well-laid shingles. A flue about 2 feet high on the apex helps to create a draft that draws up the sulphur fumes and smoke. The floor is made of strips 1 inch thick by 3 inches wide, laid on edge, three-eighths of an inch apart, just wide enough to admit the sulphur fumes and yet close enough together to prevent the nuts from falling through. The floor is about 2½ feet above the ground, and the lower space is boarded up with tongued-and-grooved strips also, and fitted with small doors every 5 feet, to permit the placing of pans of burning sulphur underneath the floor."

A cheaper structure and one quite as efficient might be constructed by sliding the trays, on which the nuts have been dried, into an upright shaft or flue, such as is used in bleaching fruit in conjunction with fruit evaporators. The utmost care is necessary to avoid overdoing the process. Only so much sulphur should be used as is required to comply with the market demand for a light-colored shell. The whole practice of bleaching is objectionable and injures the quality of the nut unless the work is very carefully done.

¹ California Fruits, page 493.

ASSORTING.

The broken and inferior nuts are generally separated from the sound ones before bleaching. They are shelled and sold as kernels. When the nuts are ready for market they are placed in common wheat sacks, holding 80 pounds of almonds, and are thus marketed. The prices received range from 5 to 20 cents per pound, those with thin shells and long single kernels selling highest, as noted (p. 21).

NOTES FROM CORRESPONDENTS.

John Markley, Geyserville, Cal., says: "Thousands of dollars were spent in planting large orchards of the Languedoc almond, many of the trees being imported from France. They grew finely but did not bear many nuts, and thousands and thousands of these trees were dug up or grafted over to the prune. But we now find it was a lack of fertilization of the flowers, and we are now relying upon the California seedlings, generally grafted upon the peach or almond root. The peach root will stand more water in the spring, and it stands transplanting better than the almond."

Alfred M. Newland, Colusa, Cal., says: "I plant the almond pit where I want the almond tree, and when it grows to a proper size I bud it, and never disturb the taproot. I claim that the tree is more vigorous and longer lived by this treatment. I find the almond does best on high sandy land well drained and well cultivated. It does not require irrigating, nor does it require so much pruning as the peach, pear, or apple. We planted some from good soft-shelled almonds thick in rows, and did not bud or graft, but let them bear, to prove themselves by the almonds they produced; we then grubbed up all of the bitter ones and hard shells and left the good ones. After that the trees were in rows one way and could be cultivated. If you plant soft-shell almonds (all off the same tree) and let them bear naturally, a majority of the trees thus obtained will yield nuts as soft shelled as those from the mother tree. Also, if you plant from a hard-shell tree, the majority will be hard, but some will be as nice and soft as a person could wish; I have a fine paper-shell variety gotten in that way, also a good soft-shell by the same method. I bud a great deal from these two varieties, as both are very prolific."

Ellwood Cooper, of Santa Barbara, Cal., says: "The soft-shell almond, Languedoc variety, is hardy and grows well, but is a very shy bearer. It does not give crops that will warrant investments in orchards. In Los Angeles [County], where tried, it did worse than in Santa Barbara [County]. The only varieties that have been tried in southern counties are Languedoc and Papershell. The latter has borne well, but the birds get all. "The woodpecker and yellow-hammer are the worst enemies. Crows come by thousands, but we can keep them off. The almonds grown in the interior are Languedoc, IXL, Nonpareil, and Ne Plus Ultra. I have tried the IXL, and it does not do any better than the Languedoc."

INSECTS, DISEASES, AND REMEDIES.

The only insect that has caused serious trouble in California is the red spider, which, according to the report of the California Board of Horticulture, 1891, is easily destroyed by spraying with a caustic solution applied during winter for scale insects, and a summer remedy prepared as follows: "Sulphur 3 pounds; caustic soda (98 per cent) 2 pounds; whale-oil soap 25 pounds; solution in all 100 gallons. Directions: Boil the sulphur and caustic soda together in about 2 gallons of water. (This is done to allow the caustic soda to dissolve the sulphur.) When the sulphur becomes dissolved add the soap and boil until thoroughly dissolved; then add water to make in all 100 gallons of solution, and apply warm."

The fungous disease that is most injurious to the almond in California is a shot-hole fungus (*Cercospora circumscissa*). It is thus described by Ellwood Cooper, of

Santa Barbara:¹ "The disease here has been very bad for several years. I can not recall its first appearance on my place. I have over ten thousand trees. They generally cast their leaves in June or July. The first appearance of the disease is a yellowish-brown spot on the leaf; very soon the round piece falls out and the leaf falls from the tree. Sometimes there are a number of such spots in each leaf; this is nearly always true. It causes the leaves to fall too soon and before the woody portion has been perfected, and hence an insignificant crop the coming year. The blight does not seem to get any worse, but it is bad enough to cause great loss in crops."

N. B. Pierce, special agent of Division of Vegetable Physiology and Pathology of this Department, who has investigated the disease, says:² "It is evident that *Cercospora circumscissa*, Sacc., has developed to a very injurious extent in California, especially in the coast region. The coast counties will always be apt to suffer most from its action because of the frequent fogs and the greater general humidity of the atmosphere. Almond leaves from St. Helena, Suisun, and Acampo, Cal., fail to reveal the presence of *Cercospora circumscissa*. Some shot-hole fungus, however, is injurious at Suisun. As a preventive, Professor Galloway suggests the application of ammoniacal solution of copper carbonate as the safest fungicide for use on the peach and almond. It is prepared according to this formula:

Copper carbonate	ounces..	5
Aqua ammonia (26 degrees)	pints..	3
Water	gallons..	45

"The copper carbonate should be placed in an ordinary wooden pail and just enough water added to make a thick paste; then pour in the ammonia and stir until all the copper is dissolved. If three pints of ammonia is not enough to thoroughly dissolve all the copper, add a sufficient quantity to bring about this result. When completely dissolved, pour the copper solution into a barrel holding 40 or 45 gallons; then fill the barrel with water. Where there are a large number of trees to treat we find it very convenient to prepare the concentrated ammoniacal solution in advance. This can be done at leisure, taking care always to put the liquid into a tightly corked jug or demijohn as soon as it is made. When ready to spray, take the concentrated fluid into the field, and for every 3 pints add 45 gallons of water.

"In order to protect the foliage from the attacks of *Cercospora* it would probably be best to begin the application of the ammoniacal solution just as soon as the leaves appear. A second application should be made in ten or twelve days, followed by a third two weeks later. It is possible that three applications would hold the disease in check. Doubtless 6 or 7 sprayings would be better and would pay in the end.

"Three sprayings should be made as directed above, the others at intervals of two weeks. For applying the solution a good strong force pump, having two lengths of discharge hose and two spraying nozzles, is necessary. Any good force pump will answer, providing it is light and strong, and the working parts are made of brass. We usually mount the pump on a barrel and attach two pieces of one fourth-inch cloth insertion hose, each about 15 feet long. At the end of each hose we fasten an improved Vermorel nozzle. About 2 feet of the hose is then wired to a piece of cane fishing rod 8 or 10 feet long, allowing the nozzle to project an inch or two beyond the pole. The barrel and pump are then placed in a wagon, while a man standing on the ground at each side of this outfit manages the nozzles. Another man stands in the wagon and in addition to looking after the horses does the pumping. By means of the long hose and the poles the spray may be quickly directed over a tree on each side of the wagon. Two trees being sprayed in this way, the horses are driven opposite two more trees when the spraying is again repeated. In this way a large orchard may be treated in a comparatively short while."

¹Journal of Mycology, Vol. 7, No. 2.

²*Ibid.*

VARIETIES.

It is a very common observation of California growers that the best almond in any locality is the seedling that originated there. Different seedlings in different localities have impressed investigators as being much healthier than any other known varieties and as showing a much better leaf and ability to resist the attacks of disease and insects.

Commercially, almonds are divided into bitter almonds and sweet almonds. The bitter almond (Pl. 4, fig. 8) varies in form and size, also in thickness of shell, quite as much as does the sweet almond. Seedlings of the bitter almond are frequently found to produce nuts having sweet kernels. The sweet almonds are divided into three general classes, namely: "hard shell," "soft shell," and "paper shell." Between these classes are unnumbered variations of thickness and form of shell. There is a form of hard-shell almond grown to a small extent in the Eastern States, which is quite similar in appearance to the stone of the peach. This is sparingly bought by druggists, but has no more market value than peach stones, except in localities where it is preferred as seed from which to grow stocks for budding. Among paper shells there are recognized two kinds, the true paper shell and what may be called a false paper shell. The false paper shell has two quite distinct shells, the outer one sometimes adhering to the hull, but more often remaining attached to the nut when the hull is removed. The paper shells bring nearly double the price of soft shells, while the hard shells are sold only in limited quantities and at lower prices. Varietal forms are as yet so inconstant among the seedling almonds of the Pacific Slope that the investigator will find himself much puzzled in determining varieties by an inspection of the nuts alone. Specimens of Nonpareil and Ne Plus Ultra received by the Division of Pomology in two consecutive years showed such marked differences that they were returned to A. T. Hatch, with the query whether there had not been some mistake in the labels accompanying them. He replied: "The samples of almonds returned by you have just been received, and I wish to say that the samples of 1891 and 1892 are as represented in each case—those marked 'Nonpareil' in 1891 and in 1892 are both Nonpareil. The same is the case in the Ne Plus Ultra. The difference comes from the difference in the ages of the trees; and in the difference of locality more than the difference in age alone. The younger trees make more hulls and less perfect shells than older trees do. Further, those sent in 1891 were grown in a cooler climate and within the influence of the winds from the sea, namely, in Solano County, while the samples of 1892 were grown in Butte County." The importance to the grower, of a closer varietal study and selection of types for propagating, is made apparent by the demands of confectioners for very close grading of the nuts offered for sale. The American-grown nuts in Eastern markets have hitherto been lacking in this regard, and though many of our seedlings are of the very highest quality their price suffers for want of sufficiently close grading.

VARIETIES GROWN IN THE UNITED STATES.

BLOWERS (*Blowers's Languedoc*).—Grown by R. B. Blowers, of Woodland, Cal.; fine nut; tree good; regular bearer.—*Wickson*.

BRIER (*Brier's Languedoc*).—Originated with the late W. W. Brier, Centerville, Cal. Medium sized, soft, light-colored shell; sweet and delicate flavor; good bearer; blossoms resist quite severe frosts.—*Wickson*.

DRAKE (*Drake's Seedling*).—Originated with Mr. Drake, of Suisun, Cal.; of the Languedoc class, very prolific, and a regular, abundant bearer.—*Wickson*. A. T. Hatch says: "The Drake seedling has a rather round kernel and very plump, most of them having double kernels, with a shell like our California Languedoc. It originated as a sucker from the root stock of a nectarine tree, the top of which had died. The tree has a rather spreading inclination."

EL SUPREMO.—A seedling grown on the farm of Mr. Wolfskill, a neighbor of A. T. Hatch. "A very thin-shelled almond with a large kernel, the skin covering the kernel being brown and very sweet. The tree is inclined to take a symmetrical form with very little pruning."—*Hatch*.

GOLDEN STATE (pl. 4, fig. 7).—Originated by Webster Treat, of Davisville, Cal. A medium sized, soft-shelled nut, somewhat larger than Languedoc. Kernel full, generally single, and with smooth skin. The nut is said to part readily from the hull, and if not promptly picked, drops out. It is said to ripen four or five weeks earlier than Languedoc and Tarragona.

GROSSE TENDRE (*Improved Languedoc*).—A soft-shelled nut above medium in size, with a good many double kernels; recently imported from the Province of Languedoc in southern France; as hardy as the common Languedoc.—*Gillet*.

HARRIOTT (*Commercial*).—A long, large, soft-shell; kernel generally single, sweet and good. Originated at Visalia, Tulare County, Cal., and is reported to be a sure cropper there. The tree is very stocky, with large leaves that hang on so long that it has been described as almost evergreen.—*Leonard Coates*.

I X L (pl. 4, fig. 4).—Large, broad, soft-shelled; kernel generally single, plump; nut hulls easily; tree upright, symmetrical with little pruning. Originated with A. T. Hatch.

KING (*King's Soft Shell*).—Originated at San Jose. Shell very thin and soft. Regular and abundant bearer.—*Wickson*.

LANGUEDOC (pl. 4, figs. 1-1a').—Introduced to California as early as 1853 and by later importations. Now very generally superseded by the California seedlings. A short, soft-shell nut, with plump, sweet kernel. Where it succeeds the tree has a habit of bearing heavy and light crops in alternate years. Charles H. Shinn thinks that the Languedoc is incapable of perfect self-fertilization, though its blossoms contain both stamens and pistils. It is found to yield larger crops when planted in proximity to thrifty seedlings than it does when planted by itself in solid blocks. At Chico, Cal., large trees of this variety, 18 to 20 years old, are reported to yield an average annual crop of one sack (80 pounds) of nuts. Large quantities of this almond are imported from France.

LA PRIMA (pl. 4, fig. 5).—A paper-shell, originated by A. T. Hatch. Nut large; kernel single, and of excellent quality. Tree not so upright in growth as IXL or Ne Plus Ultra, but more so than Nonpareil.

LEWELLING (*Lewelling's Prolific*).—Originated with the late John Lewelling. Tree a great bearer. Of drooping habit; nut large and good; soft-shell; hull free.—*Leonard Coates*.

MCCOY.—Originated near Suisun, Cal., rather small and hull adheres, but a regular bearer.—*Wickson*.

NE PLUS ULTRA (pl. 4, fig. 3).—A paper-shell; originated with A. T. Hatch, as a sucker from the seedling stock of a budded almond tree. Nut large and long, a heavy and regular bearer; it hulls freely. Tree similar to that of IXL; an upright grower.

NONPAREIL (pl. 4, fig. 6).—One of A. T. Hatch's paper shells. This was also found as a sucker growing from the stock of a budded tree. Nut thin, broad; kernel single, large, broad, smooth, excellent. Tree has slender twigs of rather drooping character.

PRIDE (*Pride of the Market*).—Nut large, smooth, bright, false paper shell; kernel quite large, often double, somewhat wrinkled and of good flavor. A self-huller that needs no bleaching or other treatment. Originated with Fish & Son, Stillwater, Cal.

PRINCESS.—A soft-shell nut of medium size, self-huller; kernel plump, smooth, good. Somewhat grown in Florida.

TARRAGONA.—An old variety of the Spanish type, formerly largely grown. A good bearer and a free huller. Nut large, shell thick but rather soft; kernel broad, considerably wrinkled; flavor less sweet than the paper shells.

OTHER VARIETIES.

A very large proportion of our almond importations come from France, Italy, and Spain. Under existing tariff rates (which are 5 cents per pound on almonds not shelled, and $7\frac{1}{2}$ cents per pound on shelled almonds)¹ it is found to be cheaper to import the shelled rather than the unshelled article. Two and one-half pounds of the nuts are required to yield 1 pound of shelled almonds, which makes the net duty $12\frac{1}{2}$ cents per pound of meats, if imported in shells, against $7\frac{1}{2}$ cents per pound for those imported without shells. Among importers the different grades are distinguished by the names of the ports from which they come. It is probable that in some cases several varieties are included under a single name, but from lack of access to specimens with shells and of more definite information concerning them only an enumeration of the names as they are found in the market, with brief references to their quality, is possible at this time.

ALICANTE.—Has large, broad kernels of excellent quality. From Alicante, Spain.

BARI, OR ALBRUZZI.—From the mainland of Italy, shipped from Bari or Livorno. Our specimens were much broken when received. The kernels are irregular in size and form, but of excellent quality—grading with Jordan and Alicante in this respect.

CANARY.—From Canary Islands. Kernel short, plump, uniform; quality ordinary.

JORDAN (pl. 4, fig. 9).—This name is a corruption of the French word “jardin” and signifies simply “garden” almond. They are imported only as kernels, principally from Malaga, Spain, and bring the highest price in our market, often from 8 to 10 cents per pound more than others. The kernels are single, narrow, long, and plump, and are rubbed or cleaned in some way before shipping. Specimens received from Malaga, through the kindness of Charles Heath, United States consul at Catania, show this variety to have a dense, thick, hard shell. We are not aware that the production of this almond has been attempted in California. The effort seems worth making on account of the high price of the product.

PROVENCE.—These are received from Marseilles and Bordeaux. They are smaller than those from Spain, and are long in form, with white meat.

SICILY.—Received from Messina. The kernels are plump, often double, and irregular in size and form. As found in the markets these are composed of a mixture of sweet and bitter kernels. But whether thus grown or whether the mixing is done by the shippers we have not determined.

VALENCIA.—As received by us, bears a close resemblance to Alicante. They come from Valencia, Spain.

THE WALNUTS.

Three species of the walnut are of commercial importance in the United States. Of these, the black walnut (*Juglans nigra*) and the butternut (*Juglans cinerea*) are native, and one, the Persian walnut (*Juglans regia*), has been introduced from the Old World. The walnuts may be readily distinguished from the hickories, which they somewhat resemble, by their thicker bark, which on trees a few years old cracks into persistent, longitudinal ridges, and by their simple aments, or catkins, composed of staminate blossoms; the bark of the hickory being scaly or smooth and the aments compound. They may also be distinguished by the thick, fleshy hull inclosing the nut, which in the walnuts bursts irregularly after it falls from the tree, while in the hickories it is regularly four-parted and valvular, often opening sufficiently to release the nut while the hull remains attached to the tree.

¹ These rates are reduced by the tariff act of 1894 to 3 cents per pound on almonds not shelled, and 5 cents per pound on shelled almonds. At the present time, December, 1895, therefore, the net duty on almond meats per pound is $7\frac{1}{2}$ cents if imported in the shells, against 5 cents per pound if imported without the shells.

The Persian walnut is largely grown for its fruit in California and the Southwest, and in acreage and value of product stands next to the almond among American nut crops.

The black walnut and the butternut have been planted to a considerable extent in the Mississippi Valley and Atlantic Coast States, but have not proved profitable for their fruit alone, though in thickly set groves on strong land the value of the timber produced may make the culture of the former profitable under favorable conditions. In the wild state their fruit yields a considerable revenue to farmers and woodsmen in some parts of the country.

PERSIAN WALNUT (*Juglans regia* L.)

(Synonyms: English walnut; Madeira nut.)

This tree is a native of western, central, and probably of eastern Asia, the home of the peach and the apricot. It was known to the Greeks, who introduced it from Persia into Europe at an early day as "Persicon" or "Persian" nut and "Basilicon" or "Royal" nut. Carried from Greece to Rome, it became *Juglans* (name derived from *Jovis* and *glans*, an acorn; literally "Jupiter's acorn," or the "Nut of the Gods"). From Rome it was distributed throughout Continental Europe, and according to Loudon,¹ it reached England prior to 1562. In England it is generally known as "the walnut," a term of Anglo-Saxon derivation, signifying "foreign" nut. It has also been called Madeira nut, presumably because the fruit was formerly imported into England from the Madeira Islands, where it is yet grown to some extent. In America it has been commonly known as English walnut, to distinguish it from our native species. From the fact that of all the names applied to this nut "Persian" seems to have been the first in common use, and that it indicates approximately the home of the species, the name Persian walnut is regarded as most suitable. All references to it in this report will be found under that name.

As a material for the manufacture of gunstocks and furniture the timber of the Persian walnut was long in great demand throughout Europe, and the high prices paid for it aroused a general interest in its culture as a timber tree. Loudon states that as much as £600 (nearly \$3,000) was paid for a large tree to be used for gunstocks in England early in the present century. The introduction of black walnut and other woods suitable for such use lowered the price, however, and greatly lessened the profits of walnut-timber culture. Since then more attention has been paid to its culture as a nut tree both in Great Britain and on the Continent. France and Spain export large quantities of the nuts, and most of the improved varieties have come from the former country.

CULTURAL RANGE IN THE UNITED STATES.

For more than a century the Persian walnut has been planted in a small way in the Atlantic States. Thousands of trees have been grown from nuts by amateurs, many nurseries have kept the tree in stock to fill small orders, and the Department of Agriculture has made at least four distributions of the trees.

From the data collected it now seems possible to determine its cultural range in the United States with some degree of accuracy. East of the Rocky Mountains the Persian walnut has been most successful in a limited area along the Atlantic Slope from New York southward through New Jersey, southeastern Pennsylvania, central Virginia, North Carolina, and Georgia. The tree endures the winters in favored locations near the coast as far north as Connecticut, Rhode Island, and Massachusetts, but has never been planted there except in a very small way. Some very fine old trees are reported from Rochester, N. Y., where they are in old gardens in the suburbs of

¹ Arboretum et Fruticetum, Vol. III, page 1423.

the city. The finest and most fruitful specimens reported are at Fordham, N. Y.; Princeton, N. J.; Germantown and Philadelphia, Pa.; and Georgetown, D. C.; some of these being a hundred years old and bearing large crops of nuts of fair quality.

From Marietta, Pa., H. M. Engle reports this tree "as hardy as the oaks." In Virginia, at Red Hill, there is a tree thirty years old, reported by I. B. Townley, that has been bearing a small quantity of nuts annually for six years. This tree was brought from Edinburgh, Scotland, when six months old, planted in New York, where it remained three years, thence removed to Staunton, Va., and after two years removed to its present location. In consequence of these frequent changes the tree died back badly when first planted at Red Hill, but has since recovered and is making a thrifty growth. It is now 20 feet high, with a trunk 8 inches in diameter at the ground. At Falls Church, Va., a number of trees planted by H. C. Williams in 1855 are thus reported on in 1891 by his son, Franklin Williams: "The trees planted in 1855 are all dead, but some planted a few years later are still alive. Their location is high and dry, and the soil is a rich sandy loam, a mixture of sand and gravel with a subsoil of yellow clay. When young the trees are healthy and grow rapidly, bloom and set well with little nuts, but the nuts drop when about the size of a pea. Occasionally we find a few matured nuts on different trees."

In Delaware a few trees have been planted, but no large ones are reported. The trunks after a few years become covered with "sores" on the south and southeast sides, apparently caused by the scalding effects of the sun's rays on the unshaded trunks. This can be almost entirely prevented by the use of a wooden shield made of 6-inch boards nailed together in the form of a V trough and driven into the ground at a sloping angle, about 1 foot to the southeast of the tree. This furnishes the required shade for the trunk until the top makes growth enough to furnish protection. It is probable that the same object could be accomplished by the use of common 4-foot plastering laths held in place by twisted wire and wrapped around the tree, as is done in Wisconsin and Minnesota to protect fruit trees from the sudden extremes of temperature caused by sun and wind.¹

Reports from Florida are almost unanimous in declaring the Persian walnut a failure there, the only exceptions being Mrs. Seth Snow, of Panasoffkee, Sumter County, who says: "It succeeds admirably in sandy loam overlaying clay;" and D. R. Pilsbury, of Sanford, who reports: "Mine made a great growth last year [1890] and bids fair to do the same this year, 1891."

There is a very general complaint in the South that the trees freeze down to the ground in winter, but the most probable cause of this general failure in Florida and the Gulf States is found in the destructive work of the *Anguillula*, a microscopic worm that infests much of the soil in those States and causes the "root knot"² of trees and vegetables.

Mr. C. E. Robbins, of Alba, Fla., writes: "I have one living tree. I have planted hundreds of nuts, but these have all died after the second year, from *Anguillulae*."

From the Mississippi Valley there are very few reports of successful growth.

In Michigan this tree is rarely planted. Some 6-year-old trees at Holland are reported to be growing well. Most reports from Ohio, Indiana, and Illinois are that the trees winterkill, though W. H. Ragan reports that in Fulton County, Ind., trees are healthy and bear well; while at Vincennes there are yet standing some trees planted by the early French settlers. E. Hicks Trueblood, of Hitchcock, Ind., writes: "Our climate is suited to their growth on rich, loose soil." From Kentucky and Tennessee there are a few reports of trees making satisfactory growth on rich soil. A few

¹ See description and illustration, Report of Pomologist in Report of Secretary of Agriculture, 1892, pages 268, 269.

² A full description of "root knot" may be found in Bulletin No. 20 of the Division of Entomology by Dr. J. C. Neal, from which we quote at some length on page 33, under "Stocks for the Persian Walnut".

reports from Louisiana are favorable, but no extensive plantings are recorded, and the same may be said of Texas, where J. F. Leyendecker, of Frelsburg, says that "twice within twelve years they have been frozen to the ground." He has a specimen growing on a black walnut stock that appears to do well, but has not yet borne fruit.

It would therefore appear that the only region east of the Rocky Mountains where there is at present any probability of successful culture of this nut extends from southern New York southward to northern Georgia and westward across Tennessee and Kentucky to the Mississippi River. Within this region the tree only succeeds in sheltered locations and on rich soil, and is often unfruitful. There is a wide range of country along the Gulf and southern Atlantic coasts where climatic conditions are apparently favorable, but where its culture is now unprofitable owing to the damage done by root knot. If it shall be found that the black walnut or any of the hickories with resistant roots afford stocks sufficiently congenial on which to propagate the hardier and choicer varieties of the Persian walnut by budding or grafting, its cultural range would be greatly broadened to the southward, and there would be some encouragement there for commercial planters. At present it can only be recommended for planting in an experimental way in the Eastern States as a shade and ornamental tree and with a view to securing hardier varieties capable of producing regular crops of fruit.

On the Pacific Slope in California and Oregon the conditions are much more favorable for market walnut growing. The tree, however, either from a lack of hardiness of its blossom buds or other cause fails to produce good crops of fruit as far north as it is enabled to make a thrifty growth of wood. Felix Gillet thinks the general failure of this nut through northern California is due to the fact that until very recently only the tender Los Angeles variety, which is exceedingly sensitive to cold, has been planted. He believes that several of the French varieties, which have already fruited with him at Nevada City, will prove fruitful in favorable locations much farther north. Luther Burbank, of Santa Rosa, writes that the Persian walnut is generally a failure in Sonoma County, though it is profitable in the southern counties of the State. "The trees thrive and grow as well in Sonoma County as anywhere, but fail to produce nuts, except a tree here and there. I discovered the cause last season [1890] and have it fully confirmed this season [1891]. Most of the trees in this section are pistillate, with one or two exceptions they are strictly so. Those having staminate flowers bear quite regularly, while the others, though full of small nuts each spring, bear no nuts. Nearly all the old trees in this vicinity were no doubt grown from a strain which is dioecious, with a tendency to produce more pistillate than staminate individuals. Another fault with some nut trees is that staminate flowers appear too early or too late to be of service to the pistillate flowers. This is a very important matter in nut culture."

But whatever may be the cause of failure in northern California it is a well-attested fact that in southern California walnut culture is well established, and in certain locations exceedingly profitable. In the fertile valleys of Santa Barbara, Los Angeles, and Ventura counties, where water is found within 10 to 15 feet of the surface and where the moisture of the shore atmosphere reaches inland some 30 miles, the area planted in walnut orchards is large and increasing annually.

QUANTITY OF PERSIAN WALNUTS PRODUCED IN CALIFORNIA.

According to the report of the California State Board of Trade the total shipment of nuts of all kinds, including walnuts and almonds, from the State in 1891 amounted to 2,623,560 pounds, an increase of 1,049,330 pounds over the shipment of 1890. As the statistics of tree planting show that the almond orchards are mainly in the northern counties and the walnut orchards in the southern, and as all but 900,000 pounds of the shipment of 1891 went from the southern part of the State, N. P. Chipman, the chairman of the committee of Industrial Resources of the State, concluded that the balance of

1,723,560 pounds was mainly Persian walnuts. To these should be added shipments by sea amounting to 94,500 pounds in 1891, making an aggregate shipment during 1891 of 1,818,060 pounds of walnuts.

The product, by years, in California is given in pounds as follows:

1885	1,250,000	1889	1,500,000
1886	750,000	1890	2,000,000
1887	1,500,000	1891	2,500,000
1888	1,000,000	1892, about.....	2,500,000

It is fair to presume that the present annual shipments from the State are at least 1,750,000 pounds, worth \$160,000. The largest cultivated walnut grove in this country, and probably the largest in the world, is said to be that of Messrs. Jones, Culton, Minor & Fowler. It contains 700 acres.

F. H. Keith, of Anaheim, Los Angeles County, shipped in 1890 nine carloads of the nuts, each car containing 136,383 pounds, valued at 9 cents per pound. He finds the returns to be about \$200 per acre. John Markley, of Geyserville, probably writing of the results obtained in the southern counties rather than in Sonoma County where he lives, says: "Planted in the proper place at the proper distance apart a Persian walnut orchard is one of the safest and best paying pieces of property under the sun, but one has to hold his financial breath so long waiting for them. It takes the common Persian walnut from ten to twelve years before bearing paying crops, and it takes California seedlings from six to eight years, but how they do pay when all conditions are right—from \$400 to \$1,000 per acre! Trees should be planted from 40 to 50 feet apart in well-drained rich land with climate and conditions like Los Angeles, Santa Barbara, and many other places in California, but we can tell only by trying and proving the place. In many places they do not fertilize. Large and thrifty trees thus fail to bear, and we are now planting the Persian, Santa Barbara, Soft Shell, Mayette, etc., and *Juglans nigra* (black walnut) in the same orchard to furnish pollen."

ORCHARD SITES.

It is evident from all that has been written that the Persian walnut, even in regions where it succeeds best, has proved to be a very capricious and fastidious ward of the horticulturist. Whatever may be the capabilities of the new varieties, the Los Angeles walnut, which constitutes by far the larger part of the trees planted, is regarded as profitable only in the counties of Ventura, Santa Barbara, Orange, and Los Angeles. And within those counties the localities of profitable production are relatively small. The condensed replies received from most of our correspondents on this subject will read: "Plant walnuts only on rich, moist, well-drained lands in valleys within 30 miles of the coast, where there is water within 10 or 15 feet of the surface." In this connection the experience of Russell Heath, of Carpinteria, may be of value to intending planters. He regards the selection of a suitable locality of the utmost importance. His first effort was in Ventura County, where, after a trial of one and a half years, he found he had made a mistake in his selection and removed to his present location. He selected ground covered with a dense jungle, of which 180 acres were cleared at an expense of over \$100 per acre and planted it to the Persian walnut. These trees are reported to have grown luxuriantly and to have made a fine and profitable orchard. It is a point of some interest to know that the timber which originally covered the ground was oak, as it is commonly believed in California that the walnut will not succeed on oak land.

This practice of planting on none but exceedingly rich land, if found to be the only successful one, will necessarily limit the acreage planted, and probably make impossible the production of enough nuts to supply the demands of our home markets, because of the comparative scarcity of such land and its value for other purposes. Experience has shown that to prevent crowding on such land the trees must not be closer than 50 feet each way, which allows but 17 trees to the acre—too small a

number, considering the risk of crop failures on some trees—to make safe the investment of so much capital for so long a time as is required to bring them into profitable bearing. Certain experiments with hardy varieties newly introduced seem to indicate that the possible range of profitable culture is much broader than has been found true in the case of the Los Angeles nut, or Mission nut, which has been planted almost to the exclusion of all others. Felix Gillet, to whose enterprise the introduction of the late blooming and hardy French varieties is due, writes that he feels warranted by his experience in saying that walnut culture can be carried on successfully on the whole Pacific Coast by planting “none but the hardy kinds, and planting them on plateaus, hillsides, rolling land, alongside roadways, around large fields and vineyards, in cordons and avenues, on soils not well adapted to other crops, and where the walnut in the course of time will grow to gigantic dimensions.”

GROWING THE ORCHARD.

Stocks.—The Persian walnut is grown both in this country and Europe, mostly on its own roots. In fact the larger part of the orchards consists of seedling trees. In Europe budding and grafting have long been practiced, and in some cases the black walnut (*Juglans nigra*) has been used as a stock. Michaux recommended to European growers that it be budded on the black walnut because of the greater value of that wood, and Baltet states that he has been successful in cleft grafting on the black walnut as a tall standard, thus securing “a twofold profit from the timber of the stem and the fruit produced by the graft.” In California it was long ago found that the California black walnut could be used as a stock for the Persian walnut. Wickson¹ mentions a tree on the grounds of John R. Wolfskill, in Solano County, budded in 1875, which had attained a height of 50 feet and spread 60 feet in 1888. Its annual yield of nuts is stated to be 200 pounds. B. M. Le Long, president of State board of horticulture, reports having some years ago budded 500 trees of the wild California stock, growing in the mountains east of Los Angeles. He used the prong method, and met with good success. Mr. Le Long states that contrary to the common belief that fruit grown on such stocks would have darker, thicker shells, an examination of fruits thus grown showed no observable difference in either flavor or color. From the fact that the tree is hardy farther north than it is fruitful, the question of stocks is not an important one except for the South, where its roots are damaged by root knot. But for the Gulf States and Georgia, the finding of resistant stocks seems to be the only possible way of making walnut growing profitable.

Dr. Neal, in his researches on root knot, comes to this conclusion, and thus describes the damage done to young trees by the *Anguillulæ*:² “In nurseries of young fruit trees the greatest mischief occurs. The soil is usually carefully prepared by heavy fertilizing and culture, and the seeds of the peach, orange, and English [Persian] walnut are sown for stocks. When the tender shoots first appear many wither and die at once; others grow vigorously till the end of the first season, when they are usually budded with known and valuable varieties of fruit. The next spring these buds put out tardily and make a weak growth; the leaves become spotted or yellow, then drop; the bud dies; feeble, straggling shoots sprout around the stem, which maintain a sickly vitality till the first drought, when the tree dies, and an examination discloses the cause in the knotty, decaying roots, without rootlets or fibrillæ. With older trees taken from healthy locations and set in infected soil the programme varies. The peach and the fig often grow vigorously one or two years and bear fruit that is very prone to drop immaturity, then the tree takes on an irregular growth of stunted limbs and small leaves. The tips of these limbs die back gradually to the body of the tree. If the soil is clayey the tree will put out feeble sprouts often for several years. With the

¹ California Fruits, page 502.

² Bulletin 20, page 12 Division of Entomology, United States Department of Agriculture.

pecan, English [Persian] walnut, and willow, older trees remain stationary a year or so and die with the occasion of a severe drought."

In a table showing the relative susceptibility of different trees he lists the pecan among shrubs and trees slightly affected by this disease, and the Persian walnut is numbered among those badly affected. Soil that is annually frozen from 6 to 10 inches deep is found to be nearly free from the worms, especially from those existing in a free state in the soil or inhabiting the soft roots of annual plants, and this may explain why portions of southern Michigan, northeastern Ohio, and New Jersey, with as sandy a soil as Florida or southern Georgia, escape the plague in the peach orchard.

"My experiments are conclusive that below 50° F. in fluid, and above that when dry, the worms are inactive, paralyzed by cold and shriveled by dryness and heat, and the inference is plain that parties wishing best results must either choose unsusceptible stocks for grafting or budding trees liable to infection by the *Anguillula*, remove to favored locations, or find some means of destroying the worms. After all, I believe the use of trees that are not susceptible to the root knot, for stocks on which to graft or bud the susceptible varieties, is the proper solution of the root-knot problem. The matter of location, soil, fertilizer, and prevention, then, need not worry the intending orchardist. Find the disease-proof tree and the thing is done, and most of my experiments have been directed in some measure to secure this result. Some seedlings of our American plums are destined to replace the peach as a stock unless the Japanese variety proves superior. I have found nothing of value for the English [Persian] walnut nor for the weeping willow."

In response to our inquiries concerning nut stocks that resisted the attacks, Dr. Neal replies: "The black walnut grew tolerably well when the Persian walnut tree was a complete failure, and I expect if it were planted on new land where the trees were to stand, and then budded or grafted, there would be a good chance to make it a success. As a rule, trees and plants that are introduced are more susceptible to the ravages of these worms than are the native kinds." So far as it is known, no experiments have been made with the California walnut as a stock in regions affected by root knot. This should be tested, and the congeniality of the pecan and other hickories as stocks for the walnut should be determined, since they are known to be free from injury or but slightly affected. It is not unlikely that some of the Southern hickories will be found congenial. A. H. Norris, of Morganville, N. Y., who has a place at Spring Garden, Fla., informs us that he grafted a few years since a number of Persian walnut scions into hickory trees (probably *Hicoria alba* Britton, *Carya tomentosa* Nutt.) that had just been transplanted. Concerning this experiment the postmaster at Spring Garden, to whom a letter of inquiry was addressed, replied: "I went in person and saw eight or ten walnuts growing in hickories. The branches of the walnut were from 1 to 4 feet in length. The grafting was done from one to three years ago. There is no doubt that they will grow, but the percentage that will live by grafting will be small, about 25 per cent." From statements made by Mr. Norris concerning the number of scions set, we believe it is an overestimate that 25 per cent of the grafts thus set succeeded. Successful grafting of a newly set tree is exceedingly difficult, and in the case of so stubborn a stock as the hickory it has rarely been accomplished. A much more promising method would be that of grafting at the crown and banking with earth, as described under "Crown grafting" (p. 15).

Selection of seed.—If seedlings are to be depended on for fruit without the intervention of budding or grafting, it is important that proper care be taken to select such nuts for planting as are likely to produce a marketable product. The tendency among those growers who have given the matter of seed selection special attention is to select for seed the largest nuts with the thinnest shells, and that is now the prevailing practice. It may well be questioned, however, whether a thinner-shelled nut than many of those now marketed from California is desirable. A firm shell of medium thickness seems desirable in the walnut, both to prevent breakage in ship-

ment and premature rancidity of the meat. In the matter of size it may be said that if the kernel is plump and fills the shell, then the larger the nut the better, from a market standpoint. It is desirable, also, that the nuts selected be from trees that combine productiveness, hardiness, and the habit of starting growth late in the spring. These qualities should be sought even in selecting seed for growing the stocks on which to propagate improved varieties.

Seed beds.—In Europe nuts that are intended for planting are kept through the winter in a "rot heap," made by piling up the nuts as soon as gathered without removing the hull. This heap must be turned over frequently in the course of the fall and winter to prevent heating. A better plan than this is that of stratification (see p. 11), using sand as the medium in which to bed the nuts. As practiced by California growers, it is thus described:¹ "A frame consisting of 10-inch boards is placed on the surface of the ground and half filled with sand. The nuts are then spread thickly (a layer of nuts 6 inches deep) and covered with about 3 or 4 inches of sand. An embankment of earth is laid all around the frame to prevent the nuts from drying. The nuts are examined from time to time and as soon as they show signs of germination are planted in nursery rows." The sand is kept constantly moist, and in case of lack of sufficient rain is watered.

To insure uniform germination it will probably be found helpful to grade the nuts according to size, bedding those of uniform size together. Large nuts generally germinate earlier than small ones of the same species.

Nursery treatment.—The soil should be deep and rich, well drained, and thoroughly pulverized. The sprouted nuts should be carefully planted 1 foot apart, in rows 4 feet apart and covered well with fine soil well firmed down over the seed. Cultivation should be frequent enough to keep the surface fine and should be supplemented by use of the hoe whenever weeds appear in the rows. If the soil is good and the season favorable the young trees make a rapid growth, and in California ordinarily make stocks suitable for budding the first season. If they are to be planted in orchards without budding or grafting, they are usually left in the nursery row until 2 or 3 years of age. This is the common practice among California growers. O. N. Caldwell, of Carpinteria, who has had an experience of twenty years in the business, writes: "I have raised trees from seed and transplanted all the way from a year old up to six, and they have grown and done well, but as far as my experience goes, I prefer to move them at 3 years of age or about that time. The best trees I have were planted at 3 years old. A part of my orchard stands where the trees were not replanted, and I can see very little difference between these and those that were transplanted at 2 or 3 years old." Very different from this is the practice of Russell Heath, a successful walnut grower at the same place. He pursues a method similar to that quite commonly followed in eastern New York some forty years ago for keeping up a supply of cherry and apple trees for planting in home orchards. That is, of leaving the trees in nursery rows until they reach bearing age. He says: "I leave the trees in the nursery rows until they have attained the age of bearing, say the eighth or ninth year. Of course nurserymen can not afford to raise trees of that description, but a man who stakes his money and his time upon an orchard can afford to wait. I would rather give \$10 for a tree that is 9 years old than to give 1 cent for a tree that is 4 years old. There is money in it because they cost me no time to cultivate in the nursery. One man will go through a nursery and cultivate 1,000 trees in half a day, but if you place those trees in an orchard you are at great expense. You can buy teams and hire men, but I tell you that even in California, with all its fruitfulness, you can't buy brains to drive those teams."

Inasmuch as Mr. Heath's plan involves the necessity of removing all or most of the side branches and the formation of a new head for the tree as well as considerable

¹ Report California State Board of Horticulture, 1891, page 154.

injury to the root system, it demands more than passing notice. It will be remembered (see p. 32) that his orchard site is an exceptionally good one and that his soil is very rich. These two facts, taken in connection with thorough and systematic cultivation, should be duly considered by intending planters, and proper allowance should be made for them. In ordinary situations and soils it is not likely that a practice that involves so severe a shock to a tree that has reached fruiting age would result in the establishment of orchards uniformly thrifty, productive, or lasting. It will in all probability be successful only in rich soil and sheltered locations. Mr. Heath's method necessitates the cutting of the taproot, and we therefore give his experience in regard to that point, quoting from the discussions of the California Horticultural Society: "Some wiseacre, who thought he knew more concerning the cultivating of nuts than any other man in California, discovered in Los Angeles that if you cut the taproot your tree would never bear, and that was published in the papers throughout the State. I said, 'Here is a "pretty kettle of fish" again. I have cut all the taproots in my orchard, and I don't know whether I am going to have any fruit. I will see about this thing.' They said that where the taproot is cut, there the decay would commence, and an insect would attack the root and eat the life out of the walnut tree, and it would finally die. I determined not to be fooled much longer in spending more money, and took two men and went right down into my orchard. I could not make any mistake, because I had cut off every taproot in the orchard. We dug down carefully by the side of a tree—I was going to be very careful about it—and after they got down below where the taproot was cut, I got my magnifying glass and said: 'Boys, you needn't use your shovels any more.' I wanted to get at this thing with my hands, and took my glass and went down in the hole. I commenced digging like a gopher, and when I got down to where the root was cut, to my surprise there were two taproots, beautiful as could be, sent out from the same place where the taproot was cut. I examined five trees in that way, and each had two taproots, and I made up my mind that the Los Angeles man that had been writing about taproots was in a dream."

Budding and grafting.—In Europe both budding and grafting of the walnut have been practiced from early times. Loudon states that both processes were much more successful in northern Italy and southern France than in northern France or in England. In the United States both budding and grafting are more easily done at the South than in the North. The methods most commonly followed in the nursery are flute and ring budding (for description and illustration see p. 13), practiced with dormant buds in the spring when the sap is in motion or late in summer, as with other fruit trees. It has been found that both methods succeed best when the operation is performed at the collar. Annular and flute budding are preferred to the shield method as being more likely to succeed and less likely to have the young shoots broken down by winds.

In the United States but little attempt at budding the Persian walnut has been made outside of California. Felix Gillet, of that State, uses both ring and shield methods, budding in summer and using only the small buds from the base of new shoots. He cuts the shield of bark to be inserted not less than 2 inches long and as broad as possible. The wood is carefully removed without injuring the base of the bud, and the branch or shield inserted in the ordinary T-shaped slit made through the bark on a smooth, round section of the trunk of the tree. A bandage is bound evenly with a uniform pressure above and below the eye to insure the contact of the entire under surface of the shield with the cambium layer of the stock. These buds remain dormant until spring, and the bandages are then cut and the tender sprout trained up to the stump of the tree, which is left several inches high, until late in summer.

Knight records an instance of successful top-working of the Persian walnut by saddle grafting:¹ "Young or last year's wood was employed both as a scion and as

¹ Transactions Horticultural Society, 2d series, Vol. 1, page 216.

the stock. Both scion and stock were allowed to unfold their buds and grow for a week or ten days before the operation of grafting was performed. Previous to doing this, the young shoots and foliage were rubbed off. Out of twenty-eight instances twenty-two grew well, many producing shoots nearly a yard long and of very great strength. The scions were attached to the young (annual) wood of stocks, which were between 6 and 8 feet high, and in all cases they were placed to stand astride the stock, one division of the scion being in some instances introduced between the bark and the wood, while in others both divisions were fitted to the wood and bark in the ordinary way. Both modes of operating were equally successful. In each of these methods of grafting, it is advantageous to pare away almost all of the wood of both the divisions of the scions, and therefore the large pith in the young shoots of the walnut tree does not present any inconvenience to the grafter."

Other methods that have been successful are cleft sap grafting (p. 15), prong grafting (p. 14), and hothouse grafting (p. 16).

Cultivation.—During the first few years in orchard clean cultivation is advised, though if well fertilized the ground may be used for low-growing hoed crops and even for smaller and short-lived fruit trees.

Pruning.—The walnut needs but little pruning, and California growers cut only those limbs that would interfere with teams in cultivating. When laden with fruit the limbs are kept propped to avoid cutting. When cutting must be done, it should be with a slanting cut from the underside of the part remaining on the tree, or the wound should be well waxed to keep water out of the large pith where decay is apt to begin.

Age of bearing and the yield.—In California the age at which bearing begins is reported at from 4 to 10 years, and in the Atlantic States at 10 to 20 years. The trees come gradually into bearing; they seldom yield more than 4 or 5 nuts the first year of fruiting and from 2 to 5 pounds the second year. Some 20-year-old trees in California yield 3 bushels of nuts per year. In Spain and south of France there are trees believed to be over 300 years old which bear from 15 to 18 bushels of nuts each.

HARVESTING.

Loudon says:¹ "The fruit of the walnut (*Juglans regia*), both in France and in England, is commonly knocked from the trees by threshing the extremities of the branches (on which alone it is produced) with long poles. By this process many of the points of the branches are broken, which causes the production of many spur-like shoots that afterwards bear flowers and fruit. Hence the custom of beating a barren tree to make it bear. Bosc considers that beating down the fruit with poles is injurious to the tree; but in France, he adds, 'as the trees are not in inclosures this barbarous practice is altogether unavoidable. If the trees were inclosed, or if property exposed by the roadsides were sufficiently respected, it would be unnecessary to beat down the nut at all, as the wind alone, when the fruit is completely matured, would be quite sufficient to detach it from the tree.'

"In gathering up the fruit that is either beaten down or has fallen naturally, those nuts which have separated from the husks are kept by themselves, taken home, and spread out on a boarded floor in an area, shed, or granary, to the depth of 3 inches. Here they are turned over daily till they become perfectly dry. Those fruits from which the husks have not separated in the fall are placed in little heaps on the ground, but still under cover, and turned over and gently beaten till the husk separates. In France care is taken to prevent these heaps from fermenting, or 'sweating,' as it is called, because that occasions change in the kernel and gives an unpleasant flavor to the oil. When the nuts have been thoroughly dried those not wanted for crushing for oil are laid by, often in wooden boxes or chests, where they are not sub-

¹ Arboretum et Fruticetum Britannicum, page 1434.

ject to the changes of the atmosphere; in such places they will retain all their good qualities for about twelve months. In Britain the nuts of the walnut may be preserved fresh and fit for the table or for sowing for a year either by burying them in dry soil or sand so deep as not to be reached by frost, the heat of the sun, or rain; or by placing them in dry cellars and covering them with straw. The latter mode is most commonly adopted by the growers of this nut for the London market. Walnuts should not be gathered until their outer covering parts readily from the shell, which will be before the covering becomes mealy. There is a critical time at which the hull leaves the shell without staining it, a result sure to follow if the hulls are allowed to remain on and become soft. After being hulled, the nuts should be well dried in the sun for a day or two and then stored away, either on shelves in an airy room or packed in jars or boxes in dry, white sand, which improves the color of the shell, and keeps the kernel more moist."

Concerning Loudon's advice not to gather the nuts "until the outer covering parts readily from the shell," it must be said that it can not always be followed in the United States. There appears to be a marked difference in this respect due either to a difference in varieties or to a cause not yet understood. In some portions of California and in Delaware the hulls open on the trees and the nuts fall to the ground as freely as do the almond and the shellbark hickories, while the reports indicate that in portions of Arkansas the hull is as persistent as that of the black walnut, even after the nut is fully mature. In southern California the Persian walnut commences ripening about the last of September. Where the nuts "pop out of the hull," as some correspondents express it, the practice is to clear the ground in September of all leaves, and pick up the fallen nuts about once a week. California growers are very generally opposed to beating the trees with rods, believing that the dormant fruit buds are injured thereby. Where the hull remains persistent after the nut falls to the ground the practice of harvesters is to leave the nut on the ground until the green hull turns dark. The hull is then removed by hand or by placing the nuts in a revolving churn or some such suitable device. A revolving cylinder with internal projections to hatchel off the hulls of nuts with fragile shells would doubtless be useful in hastening this process. Where the hulls have discolored the shells the nuts are washed to remove stains. Some growers bleach the nuts with sulphur fumes, but this practice should be discouraged, owing to its injurious effects on the quality of the meat. In the larger orchards gangs of hands are started after the nuts have commenced to fall. Taking row by row through the orchard these men slightly jar each tree that the ripe nuts still on the tree may fall. The nuts are picked up into baskets and taken to the drying house. As soon as the first round is finished the second is commenced. In four or five rounds the crop is gathered. By this method Mr. Heath harvests the crop of his 180-acre orchard.

The soft-shell ripens a little earlier than the common nut and they both vary somewhat according to the season. Mr. Sexton generally commences to pick on the 10th to the 15th of September, and the gathering continues during a month or six weeks. The walnuts are picked up and put in sacks and barrels, so as to be easily handled, and are then hauled to a sunny place to dry.

CURING.

The curing of walnuts for market is an operation demanding much care. They are dried on platforms or trays, either in the sun or by artificial heat, and when properly cured they will not turn rancid or sour for several months in an ordinarily dry, cool place. The platforms for sun-drying are made of narrow boards with spaces one-fourth of an inch wide between the boards. The platform should be about 8 feet wide, 40 feet long, and the beds should be covered with canvas at night to protect the nuts from dew. The nuts should be stirred once or twice each day, and with favorable weather they will dry sufficiently in three days to be ready for market. Mr.

Sexton dries his walnuts in the sun, and they have given good satisfaction, and for small orchards he thinks this the cheapest and best way, though where large quantities must be handled artificial heat must be used. Mr. Heath uses a simple drying house, in which the nuts are subjected to a heat of 200° for six or seven hours, the nuts not being removed until they are thoroughly cured. He affirms that this mode of curing does not injure them for use as seed.

MARKETING.

The walnut is marketed in sacks, the greater portion in what are called walnut sacks, which hold about 120 pounds. Some growers screen the nuts, assorting the different sizes. The prices realized by growers, as recorded in different reports, range from 4½ to 20 cents per pound. A few nuts are gathered green for pickling and for catsup.

In France the cheap nuts are sold to the oil mills and the finer ones are shipped to market. One hundred pounds of walnuts will produce about 18 pounds of oil. It is said that half the vegetable oil used in France is walnut oil, or about three times more than is used of olive oil. We are not aware that walnut oil has ever been manufactured in the United States.

NAMED VARIETIES.

Owing to the fact that the Persian walnut has been mainly propagated by means of seedlings which exhibit many variations, it is difficult to select distinct types for description. However, in regions where walnuts are largely grown, different strains have been developed which are worthy of perpetuation, and the best of these that have reached us have been illustrated and described.

BARTHÈRE.—A French variety recently introduced by Mr. Gillet, described by him as follows: "A singularly shaped nut, elongated, broad at the center, and tapering at both ends; the shell is harder than that of other sorts."

CHABERTE (pl. 5, fig. 5).—An old French variety named after its originator. It is rich in oil and is cultivated on a large scale in the east of France for the oil mills. The tree is said to thrive on less fertile soil than is necessary for Mayette and Franquette. It is late in starting growth in the spring.

CLUSTER (pl. 6, fig. 1).—This variety is noted for its habit of growing in clusters of 8 to 15 nuts, and in some cases even 20 to 28 nuts.

DREW.—From William P. Corsa, Milford, Del. Size of nut above medium; form oblate, with roundish base and compressed apex; surface moderately smooth, yellowish; shell quite thin, cracking qualities excellent; kernel short, thick, plump, light yellow; meat yellowish white; flavor sweet, rich, slightly astringent; good to very good. The nuts are self-hulling, and ripen with or without frost about October 1. It is a seedling grown from a nut, probably imported, planted about 1875 by the late Andrew Corsa (for whom it has been named), and by him given, when one year old, to his brother on whose farm in Sussex County, Del., the original tree now stands.¹

The tree remains dormant until late in May, the blossoms thus escaping injury by frost. It commenced bearing in 1890, and has yielded an increasing quantity each year since.

FORD (*Softshell*) (pl. 6, fig. 3).—Illustrated from specimens received at the Department of Agriculture from George W. Ford, of Santa Ana, Cal., by whom they are being propagated. From selections made in 1880 of some of the best and largest nuts from trees previously introduced into Santa Barbara County, Mr. Ford has grown orchards of bearing trees which have gained considerable reputation among

¹ This tree twice transplanted, and being injured while young by sun scald of the trunk, was cut back to the ground line when 6 years old. A sprout from the stump was protected from the sun's rays by two boards nailed together at their edges, placed on its southeast and southwest sides and left until the tree made top enough to shade its trunk. Since then no protection has been needed.

walnut growers. It is claimed for these nuts that besides being soft-shelled they have admirable keeping qualities, and that the trees are abundant croppers.

Our illustration shows but one of several forms received from Mr. Ford. As he propagates entirely from seed, there is some variation in the nuts he sends out, and no distinct variety has been selected for propagation. Mr. Ford's nuts average well, and are much superior in thinness of shell and quality of kernel to the common Los Angeles nut.

FRANQUETTE (pl. 5, fig. 4).—Form long; size quite large. A French variety named after its originator, by whom it was propagated in the early part of the century. By Mr. Gillet it is rated with Mayette and Parisienne as very choice in quality, regular in form, hardy in tree, and late in starting growth in spring. The productiveness of these varieties in the United States has not been determined; but young trees are reported to fruit well at Nevada City, Cal. These three varieties supply the finest walnuts produced in the southern portion of France, where they are exclusively grown on grafted trees and are the kinds most generally grown.

GANT, OR BIJOU (pl. 6, fig. 4).—A very large French nut, the kernel of which often fails to fill the shell. The names are derived from the uses to which the shells are sometimes put in France, being used as glove or jewel boxes.

GRAND NOBLESSE (pl. 6, fig. 2).—A very fine nut, of which specimens were received by Division of Pomology from L. L. Bequette, of Rivera, Cal.

LANFRAY.—A large imported variety catalogued by Mr. Gillet. We are not aware that it has yet been fruited in this country.

MAMMOTH.—French. "This is an immense nut, the largest of all, much larger than Gant, or Bijou."—*Gillet*.

MAYETTE (pl. 5, fig. 3).—Form broad; size above medium. This is one of the finest dessert nuts, and is quoted at the highest prices in the market. The nuts are above medium in size, full kerneled and sweet. Its habit of starting growth late in the spring makes it of special value to growers in the United States. It is thus likely to escape disastrous effects of late spring frosts.

MESANGE.—A very thin-shelled French variety that is claimed to be especially desirable for pickling when green. Nuts sometimes injured by birds, which puncture the hull and shell and extract the meat.

MEYLAN.—Recently introduced from France by Felix Gillet. Said to have originated near the village of Meylan, where it is much cultivated for export.

MISSION (*Los Angeles*) (pl. 5, fig. 1).—This nut was introduced by the priests at Los Angeles and is the pioneer Persian walnut of California. Most of the bearing orchards of the State are composed of seedling trees of this type. The nut is of medium size, with a hard shell of medium thickness. It succeeds admirably in a few favored districts (noted on page 32), but fails in productiveness in many sections. Its most prominent faults are early blooming, in consequence of which it is often caught by late frosts; the irregular and unequal blooming of its staminate and pistillate blossoms and the consequent failure of the latter to be fertilized and to develop nuts; lateness in ripening its wood in the fall and consequent liability to injury by frost at that time. In sections where it does not succeed the trees of this variety should be top-grafted or budded with hardier varieties.

PARISIENNE.—Originated in southeastern France and named in honor of the capital. Nut large, truncated at apex. Said to be as late in blooming as Mayette.

POORMAN.—Recently introduced by Mr. Gillet, but not yet fruited.

PREPARTURIENS (*Fertile*) (pl. 5, fig. 2).—Size medium; shell rather hard; kernel delicious. This variety originated about forty years ago in France. It bears at an early age, as its name implies. It blooms from two to four weeks later than the Mission, and is thus less likely to be injured by late frosts. Its male and female blossoms mature simultaneously. It is very hardy and ripens its wood well before winter. Its habit of growth is more dwarfish than some others. It is productive. Until 8 or 9

years of age the trees of this variety are said to produce no male blossoms, though female flowers or nutlets are frequently found even on very young trees. Such nutlets may be grown to maturity if pollen is supplied from other walnut trees in the neighborhood. For the family garden Mr. Gillet thinks this variety has superior claims in quality of kernel, thinness of shell, fruitfulness, and precocity in bearing. Mr. Gillet reports that in 1881 grafts of this variety were set in a large walnut tree at Nevada City. The tree was 21 years old and measured $2\frac{1}{2}$ feet in diameter, but had previously borne only 17 nuts, all in one year. In 1884 those grafts bore over 400 nuts, and in 1887 their yield was 5 bushels. Mr. Gillet asserts that the trees grown in California, from nuts borne on trees grafted from the imported, bear nuts of larger size than the parent trees. These he designates "second generation" trees. Seedlings from these (third generation), he says, show a marked deterioration in size, though they retain the thin shell and good quality.

SANTA BARBARA (*Softshell*).—This variety is about ten days later than the Mission in starting growth and in blooming in the spring. It fruits at from four to six years from seed, and usually produces a full crop every year. It is not as strong a grower as the common walnut (Mission), and more trees can be planted to the acre. The shells are thin and easily broken, consequently the nuts are sometimes damaged in long shipment. The kernel is white and of very fine quality.

SEROTINA (*Late Walnut, St. John*).—A nut of medium size, with high-flavored kernel. This is perhaps the latest walnut in putting forth growth in the spring on the Pacific Slope, and for this cause it is especially selected by planters for sections liable to have late frosts. It is an old French variety described by Loudon. Mr. Gillet says: "It is this variety that produces the 'After St. John walnut,' nurserymen marking out every Serotina in nursery rows that puts forth [blossoms?] about St. John's day [June 24], and selling such trees under the name of 'After St. John walnut.'"

SEXTON (*Papershell*).—Named and propagated by Joseph Sexton, of Goleta, Cal. It is a very thin-shelled nut of good quality. It is about ten days later starting growth in the spring than the Mission nut. It is more upright in growth of tree than the Mission, and for this reason is set in orchard by Mr. Sexton at 40 by 40 feet.

VOUREY.—Recently introduced from southeastern France. Similar to Mayette in form, and said to be one of the hardiest varieties yet introduced.

A few other varieties are catalogued by Mr. Gillet, but they lack sufficient test to prove their value in this country.

JAPANESE WALNUTS (*Juglans sieboldiana* Maxim.; *J. cordiformis* Maxim.; *J. mandshurica* Maxim.).

These nuts, the two former of which are natives of Japan and the latter of eastern Asia, have been planted for some years in California and other States with a good prospect of becoming useful economic trees. They are certainly worthy of widespread trial where our native walnuts thrive. They are very closely allied botanically, and no distinct characters seem to have been noted except in regard to the form, size, and smoothness of the nuts, the varying thickness of shell, and the quantity and quality of the meat. Of the three, the nut of *J. mandshurica* bears a close resemblance to our butternut, *J. cinerea*, while that of *J. sieboldiana* more resembles an elongated form of Persian walnut, and *J. cordiformis* a small, thin-shelled, heart-shaped form of the same species. Of the similarity of wood, foliage, and manner of growth of the different species of Japanese walnuts, Luther Burbank says:¹ "Among the many thousand seedlings which I have raised from *J. sieboldiana* and from the Towerhouse trees I have watched in vain for the least variation in foliage or growth. Even *J. mandshurica* and all the various forms which are obtained from Japan and Korea are so much alike in foliage and growth that no one has been able to observe any difference in young trees."

¹ American Garden, March, 1891.

While it seems probable that the tree now known as *J. cordiformis* will eventually be considered a botanical variety of *J. sieboldiana*, the differences in the nut characters seem of sufficient importance from a pomological standpoint to warrant their discussion here as three distinct species.

JUGLANS SIEBOLDIANA.

This seems to have been the first of the Japanese walnuts introduced. The oldest tree now known to be growing in the United States having been grown from seed planted about 1860 by a Mr. Towerhouse in Shasta County, Cal. The beauty of the tree and the desirability of the nut attracted attention; its identity was unknown until determined in 1881 by G. P. Rixford, to whom the matter was referred by the California Horticultural Society.¹

It is now widely distributed, being mentioned by correspondents in 1891, as grown in California, Florida, Michigan, New Jersey, and Texas, though there was no record at that time of its having fruited outside of Shasta, Sonoma, and Butte counties, Cal. The nut is ovate in form, with a sharpened point and smooth shell, which is thicker than that of the Persian walnut, but thinner than that of the American black walnut; the kernel has the flavor of the American butternut, but is less oily. Its quality is superior. The nuts are borne in clusters of twelve or fifteen each at the tips of the previous season's branches. The clusters of pistillate blossoms stand at an angle of 45° to the branchlets, and later, as the nutlets increase in size, the long slender stem gradually curves until the cluster becomes pendant. The tree is described by Luther Burbank as follows: "This species is found growing wild in the mountains of northern Japan, and is, without doubt, as hardy as an oak. The leaves are of immense size and a charming shade of green. The trees grow with great vigor, assume a very handsome form, need no pruning, mature early, bear young, and are more regular and productive than the English [Persian] walnut. The tree makes a more rapid growth than the shellbark hickory, the pecan, the Eastern black walnut, or the Persian walnut, but does not grow as fast as the native black walnut of northern California."

Concerning its propagation, Mr. Burbank states:² "It is easily grafted on our common walnut (*J. Californica*), and its trunk retains the same dimensions as the stock; but it is by seed that it should be multiplied. It reproduces itself perfectly true, and if the younger plants remain bushy during the first year, the tree shoots afterwards, and, thanks to its rapid growth, promptly assumes large dimensions."

JUGLANS CORDIFORMIS.

This nut, which is said to be indigenous to the Island of Yezo, the most northern portion of the Japanese Empire, was but recently introduced. It has not fruited in California, but is reported as making a satisfactory growth in Sonoma County.

Mrs. H. H. Berger says, probably concerning its behavior in Japan: "Its Japanese name, Hemi-Kurumi, is derived from its distinctly heart-shaped sharp-pointed fruit. The tree, which is of fine appearance, bears at four years from the seed and is said to attain a great age. As a dessert nut its fruit equals the Persian walnut in flavor, and the peculiar heart-shaped form of its kernels, which can be extracted whole by boiling the nuts for about five minutes and cracking while still hot, gives it a peculiar value for table use. The meat is very sweet and is much used in the form of candied nuts. The species is of easy culture, and accommodates itself to any soil where the English walnut will grow."

Mr. Burbank says: "I am thoroughly convinced that some of the best varieties of *J. cordiformis* will prove to be of inestimable value. The meat, which is large and of

¹ W. J. Klee, in *Arid Regions of the Pacific Slope*, 1882, page 142; also Wickson, *California Fruits*, page 507.

² *American Garden*, 1890, page 708.

best quality, is removed entire with but a slight tap, as the shell is very smooth and thin. In form and size the nuts vary as much or more than the shagbark hickory, and no doubt can be much improved by selection and cultivation; and as they can probably be grown wherever any walnut can be, they should be disseminated as soon as possible. The young trees grow rapidly and are not distinguishable in the nursery rows from *J. sieboldiana*."

JUGLANS MANDSHURICA.

This species, from eastern Asia, as previously noted, bears a close resemblance to our butternut in habit of growth and foliage, and in the form and appearance of its nuts. Trees grown from seed received from Pekin, China, some years ago and planted at Arnold Arboretum are hardy there and have borne fruit for several years. For pomological purposes this seems to be the least promising of the three kinds, owing to the rough, thick shell of its nut.

HYBRID WALNUTS.

The use of both the California walnut (*Juglans Californica*) and the Eastern black walnut (*Juglans nigra*) as occasional trees in the Persian walnut orchards of California, for the purpose of supplying pollen to fertilize the blossoms and insure crops, has led to considerable inquiry as to the possible or probable results to be obtained by crossing one species of *Juglans* with another.

The Vilmorin walnut (pl. 7, fig. 8), supposed to have originated near Paris early in the present century, gives evidence of being a hybrid between *Juglans regia* and *Juglans nigra*. Felix Gillet, who grew the specimen from which the illustration was prepared, says of it: "I keep it simply as a curiosity. The nut has the shape of a European walnut, but the hard and rugged shell of the Eastern black walnut. I do not see any direct benefit derived from the crossing of the two species, for it certainly does not improve the European walnut and improves the black walnut but very little. I have several grafted trees of the Vilmorin in bearing; of these, two trees produced several nuts last year that matured, though the trees produced no male catkins; the nuts having [probably] been fertilized by the catkins of Chaberte trees close by. The pistillate bloom on the tips of the nutlets of the Vilmorin is pink colored, while that of other walnuts is white. My trees were covered with those nutlets this spring [1891]; though there were no catkins nor staminate flowers on those trees, I expect that many of the nuts will have been fertilized from the catkins of one or more varieties of *regia* that grow in the neighborhood and which were in bloom at the same time. The foliage of the Vilmorin is of a much lighter green than that of any variety of *J. regia*, and the edges of the leaves have small teeth, but not so closely set as those of the Eastern black walnuts."

In 1877 Luther Burbank crossed *Juglans regia* on pistillate flowers of *Juglans Californica*. The resultant nuts were planted in 1878, and in ten years the tree from one made the remarkable growth of 12 inches diameter at 2 feet from the ground. It was then accidentally destroyed. Buds that had previously been secured and set on other stocks show the same luxuriant growth of wood and foliage. Trees of these, four years from bud, transplanted to a hard sidewalk, were in 1891 said to be as large as, and taller than, 18-year-old *regias* on cultivated ground near by. They are as large as *Californica* trees 10 years of age; the leaves have a very strong, delightful fragrance of new apples, unlike any other tree. The bark is light colored, thin, and very smooth. Specimen leaves nearly a yard in length, and a photograph of the budded tree, sent to the Division of Pomology in 1892, indicate that the tree is a shapely, symmetrical grower that furnishes abundant shade. Mr. Burbank says: "No other tree that I have seen, except *Eucalyptus*, will equal this in growth." This tree has not yet fruited. He has some crosses of *J. nigra* and *J. Californica*, of which one is 6 years old and exceedingly handsome.

BUTTERNUT (*Juglans cinerea* L.)

(Synonyms: White walnut, Oil nut.)

The butternut is native over an area that differs but little in extent from that covered by the black walnut. It extends farther east and north, however, and is not found so far to the south and west. It is found from southwestern New Brunswick westward across Maine, Quebec, Ontario, the lower peninsula of Michigan below latitude 44°; Wisconsin below Green Bay, northwestward to the neighborhood of Duluth, Minn., and the headwaters of the Mississippi River, southward across central Iowa, Missouri, and southeastern Kansas into the Indian Territory. Its southern limit reaches the Arkansas River in Arkansas and extends southward across central Mississippi and Alabama to the eastern base of the Blue Ridge Mountains, reaching the Atlantic Coast near Norfolk, Va. The tree is found most abundant and reaches its highest development in the Ohio River basin. There are relatively few sections where it is reported as an abundant forest tree, and in some localities within the area of its native growth it is found to be a difficult tree to grow under cultivation, though in general the nut germinates readily and the tree grows rapidly. It is not suited to prairie situations, as the trunk often sun scalds quite as badly as does that of the Persian walnut. In forest growth it is not commonly an abundant bearer, but finds its greatest fruitfulness in open groves and along fence rows. Trees bear a few nuts at from 7 to 12 years of age, and increase annually until, as some reports state, there are single trees of large size that yield from 15 to 20 bushels of nuts in a season. Reports mention a noticeable difference in size, also in the cracking qualities of the butternut, and it seems desirable that care should be exercised by growers to select for propagation the best types of this nut. In flavor and quality of kernel, the butternut is second only to the shellbark hickory and pecan among our native nuts, and is worthy of more attention than it has received.

In curing, care should be taken, as with the black walnut, that no grit gets into the rough shells, for it materially lessens the attractiveness of the nuts in market and damages both their value and sale.

Were it marketed in larger quantities it would probably be able to win its way more readily into favor. The person who will supply its meats fresh and in clean, convenient form for culinary and dessert uses will have little trouble in stimulating a demand. Possibly some improved method of cracking the shells and removing the meats, or the discovery of some "sport" that will afford a thin-shelled variety will be necessary to bring the cost of preparing them within the limits of a popular price. In its green state it is used for pickling and for catsup much the same as is the Persian walnut. The ripened nuts sell for about the same prices in the local markets as are obtained for black walnuts, varying from 20 cents to \$2 per bushel. From correspondents reporting the yield of butternuts per tree we note the following data: Indiana, from one-fourth bushel to 40 bushels; Connecticut, one-half bushel to 20 bushels; New York, 1 to 20 bushels; Vermont, 1 to 20 bushels; Michigan, 1 to 15 bushels. From most of the States reporting, and in a majority of reports from all the States, the yield per tree is below medium in quantity, and the tree is not listed among those producing profitable crops. George P. Pepper, of Pewaukee, Wis., reports a butternut tree which at 16 years old produced 6 bushels of nuts. This may be considered the maximum under good culture.

In a paper on "Orchard trees for Minnesota," L. B. Hodges says: "Either the butternut or black walnut would 'throw in the shade' any apple orchard in the State; that they would come into bearing as quick, would grow faster, stand more neglect and bring more bushels of either fruit or dollars in the long run." This statement needs modification so as to apply only to river bottom land in Minnesota, for on open prairie, as above noted, the tree is not hardy.

Several instances of supposed hybrids between the butternut and the black walnut and butternut and Persian walnut have been reported. Arthur K. Harrison states there was at one time in Columbia County, N. Y., a butternut tree which bore fruit externally normal, but which contained a solid cylindrical kernel some three-fourths of an inch long, pointed at the ends. This variation was possibly due to abnormal blossoms, as is suggested in the case of the "peanut walnut" (page 47). The tree is now dead and we have been unable to secure specimens of the fruit for examination. A typical nut of the species *J. cinerea* is illustrated on plate 7, fig. 4.

BLACK WALNUT (*Juglans nigra* L.).

The black walnut is one of our most widely distributed and most valuable forest trees. It is found native from southern Vermont, westward through New York, Ontario, Michigan, and Wisconsin to St. Paul, Minn., southward across Iowa, Nebraska, Kansas, Indian Territory to southern central Texas. It is not found along the Gulf or southern Atlantic Coast. The forestry report of the Tenth Census states that the tree reaches its greatest development on the western slope of the southern Alleghany Mountains and in the rich bottoms of southwest Arkansas and Indian Territory. The nut has an oily meat of peculiar flavor which is less popular than that of many other nuts. As expressed by a writer in *Orchard and Garden*, 1891, page 69, "The black walnut is among nuts what bacon is among meats—strong and greasy." Doubtless part of the popular prejudice against it in the market has arisen from the notoriously bad methods which prevail in gathering and marketing it. The nuts are often left exposed to the weather for several weeks after gathering, either before or after the hulls are removed, and in either case many of them become discolored and moldy. The rough shell becomes filled with grit, so that it is very difficult to keep the kernels free from sand while cracking and removing them.

HARVESTING THE WILD NUTS.

The nuts should be gathered soon after they fall from the trees, and the hulls should be at once removed. This is easily done by running them through an ordinary corn-sheller, which tears the covering loose, so that the nuts can be readily picked out by hand. They should then be exposed to the sun on a clean roof till thoroughly dry, and stored in a cool, dry place to prevent rancidity. Black walnuts thus handled will be found to have a whiter, sweeter kernel than those commonly found in the market.

PROFITS FROM PLANTING.

Concerning the possibility of reaping profits from black walnut plantations much has been written and predicted, but very little has been actually proven except that, for the nuts alone, such plantings have not been profitable. We give the conclusions of two growers who have made field experiments that have continued long enough to throw some light on this disputed subject. B. Hathaway, Little Prairie Ronde, Mich. writes: "I have 100 trees, planted thirty years ago; I gather nuts generally from part of them, though it seldom pays for the labor, so far as I gather for market. There seems to be but little demand; could I get 50 cents per bushel for them by the quantity, barreled, on board cars, it would pay something, but less than apples by half."

J. V. Sweeny, Omaha, Nebr., says: "I have been experimenting in walnut cultivation on a moderately large scale for the last eight years. I am located in central Nebraska—the land of the prairies—where it was once thought that the trees would not grow. I bought my walnuts from a neighbor, who himself planted the seed only twelve years ago from which these grew. I paid \$1 a bushel for 25 bushels that were produced on less than an acre of land. There are \$25 per acre for his crop, in addition to a year's growth of the trees on land that could not be sold for \$15 per acre without the timber. No cultivation or care whatever after the first four or five years,

except occasional pruning, is necessary. My experience leads me to make the following suggestions: First, any land that will grow corn will grow walnuts. Second, they thrive best on low, damp soil (not, of course, where water stands around them). Third, nuts should be left on the ground, not in piles, until the husk has rotted off. Piling is apt to result in heating the nuts. After the husk is off they can be stored until used. Fourth, for planting, either spread on the ground and cover with light mulch, so they can freeze readily, or plant at once where wanted to grow. Fifth, plant about 2 inches deep, 4 feet apart in rows that are also 4 feet apart, so they can be cultivated like corn. If seed is scarce or expensive, make the rows 8 feet apart and put a row of corn between. Sixth, trim them every year, with the purpose in view of growing tall, straight trunks. Seventh, cultivate until trees are high enough for their shade to prevent weeds from growing. Eighth, when they have become so large that they crowd one another, thin them out, saving most vigorous and straight trees as much as possible. Ninth, I want to impress everyone who grows walnut and timber trees with the importance of frequent trimming. But trimming must be done for a purpose, and with intelligence. The object sought is a tall, straight trunk. Too much trimming retards the growth, therefore never cut off a limb unless that limb is turning the body to one side, or is growing faster than the upright body, in which case, I think it preferable to prune the branch enough to retard its growth and let the upright trunk get a start. Tenth, don't think you are too old to plant trees; if you are 50 years old you are liable to live to see each tree worth \$50, and perhaps to have sold \$50 worth of nuts off of each tree. Eleventh, never transplant a walnut or hickory tree. Their long taproot makes it almost impossible to do this without injury. You will get a tree quicker by planting a nut where you want a tree, and will have much less work about it."

PROPAGATION.

From the fact that but little variation has been found in either size of nut or thinness of shell, there has been but little incentive to propagators, and but little has been done in propagating the black walnut except by the growing of seedlings. It is sometimes used as a stock for the Persian walnut, and for this purpose it is likely to have increasing value in the future.

So far as reported, we infer that both ring budding and cleft grafting at the collar of stocks one or two years old are methods reasonably sure to succeed. W. N. Irwin, of South Salem, Ohio, reports gratifying results in shield budding the Taylor black walnut on ordinary 1-year-old seedling stocks. The scions were cut late in the fall, stored in an ice house, and thus held back till the stocks would peel readily in the spring. From the dormant scions, buds were cut in the ordinary shield form, and with the wood left in the bark, to which it was firmly attached, they were set in stocks near the ground, and securely tied with bast. In about ten days thereafter the union with the stock was sufficient to warrant cutting off the stock just above the bud, which insured a rapid growth. This method of holding buds dormant and inserting them in the spring has long been practiced on the peach and other fruit trees where the fall budding in nursery rows fails to "take." By its practice, rows of varieties otherwise badly broken may be restored in the nursery, and in growth such restored spots will be scarcely less than the average of the fall buds at the end of the growing season.

CHOICE WILD VARIETIES.

GORDON.—Specimens from R. D. Buford, Bedford City, Va. Size large; form cubical, slightly conical at each end; shell of medium thickness; cracking qualities good; kernel light-colored, plump; quality excellent. The tree is from a nut planted by John Gordon, a Revolutionary soldier, and has now a trunk 3 feet in diameter and a spread of 60 feet in its branches.

MIRZA (pl. 7, fig. 3).—Received from W. H. McKinney, Morrow, Ohio. A large nut with thin shell. Kernel large and of good flavor. Mr. McKinney writes: "I have been planting this seedling for fifteen years. It and another are seedlings from two trees on second bottom land; they now are about 45 years old and measure 36 to 40 inches in diameter at 1 foot from the ground."

MISSOURI.—Specimens from J. H. Rose, Galt, Mo. Size medium; form oval, compressed, with quite smooth shell; cracking qualities good; kernel light-colored, plump; flavor pleasant, quite free from the grossness characterizing the species; quality very good.

"PEANUT" (pl. 7, fig. 2).—Received from W. N. Irwin, South Salem, Ohio. It is a rather small pyriform nut. Its name was given because of the resemblance of its kernel to that of the peanut. The shell is thin, and is easily cracked, while the kernel, which is in the larger end of the nut, comes out entire. The peculiar form is apparently due to some defect in the pistil, as but one side of the nut "fills" and matures. A large proportion, though not all, of the fruit on the tree is of this form each year. The kernel is white and of delicate flavor.

TAYLOR (pl. 7, fig. 1).—From W. N. Irwin, South Salem, Ohio. It is a quadrangular pointed nut of good size. The shell is thin and easily broken with a slight blow. The kernel is large, coming out in halves; the meat is white and of fine quality.

THOMAS.—Specimens from James W. Thomas & Sons, King of Prussia, Pa. Size large; form oblate, compressed, slightly pointed at base, considerably so at apex; shell medium to thin; cracking qualities medium, the kernel not easily removed in perfect halves from the shell; flavor sweet, rich; quality good to very good.

CALIFORNIA WALNUT (*Juglans Californica* Watson).

The correct botanical position of this, the native walnut of central California, is yet open to discussion. It has been included under *Juglans rupestris* of Englemann, a species whose type is found in Texas and Arizona, as a low, many-branched shrub; but because of the larger growth, both of tree and nut, as well as its comparatively distinct area of distribution, we have followed the specific name given by Watson, as noted above. Its chief value to the pomologist would seem to lie in its availability as a stock for the Persian walnut, and possibly as a supplier of pollen for varieties of that nut which fail to set fruit when planted by themselves. Though sometimes marketed in California, its nuts have too small a proportion of meat and are inclosed within too hard and thick a shell to have any considerable market value.

Wickson¹ says of it: "This nut is first in importance among the native nuts of California. The tree is described as attaining a height of from 60 to 75 feet, with a diameter of trunk of 2 to 4 feet. It is more graceful than the grosser Persian walnut; not so heavy as the great black walnut of the West, nor so open, light, and airy as the white butternut of the Eastern States. The nut is roundish, somewhat variable in size, much smoother than the Eastern black walnut, and the kernel is sweeter and of a more delicate flavor. The tree prefers deep, moist soils, and is usually found along the creeks. Its range is from the central zone of the State southward to Santa Barbara, and from there eastward through southern Arizona into New Mexico and Sonora. The tree is a popular shade and avenue tree, and the root succeeds admirably as a stock for the Persian walnut."

Theodore B. Hall, Yuba City, Cal., writes: "The California black walnut, which is native to some parts of the State, bears a nut a little smaller than the Eastern black walnut, and without the peculiar flavor of the Eastern nut. Tree a rapid grower in this locality; planted largely for shade, especially along roadsides. Nut good; sold in all the markets cheap."

¹ California Fruits, page 58.

John S. Calkins, Pomona, Cal., says: "Both nut and tree are inferior to the Eastern species." From the southern portions of California this tree is reported abundant on the hillsides, in the foothills, and along the water courses. In places it is called the "river nut," from its abundance along streams. The nuts vary greatly in size and form; the larger varieties are reported as being marketed at 2 cents per pound.

(*JUGLANS RUPESTRIS* Englemann.)

This tree is most abundant in Texas and Arizona, extending into California, and covering a portion of the territory occupied by *Juglans Californica*. It is found on borders of streams and in mountain canyons, on rich soil. The tree is shrubby and dwarfish, and the nuts small, hard-shelled, and of little apparent value. C. F. Thornton, Chrystoval, Ariz., writes: "In the mountains of central and eastern Arizona, at altitudes of 2,000 to 4,000 feet, it appears in stunted growth, with small, worthless nuts. The timber is likewise worthless.

J. B. Stephens, Bluffdale, Tex., says: "The black walnut [evidently *J. rupestris*] of this country is very different from that of the Alleghanies. The nut is so small that the kernel is almost worthless. It is very abundant." W. J. Maltby, Baird, Tex., says: "They are small and dwarfish, but profuse bearers. Not fit for market."

THE HICKORIES.

Of the eight or nine species of the genus *Hicoria* but four are worthy of the special attention of the nut grower as trees likely to produce marketable fruit in profitable quantities. First among these is the pecan, *H. pecan*; followed by the shagbark, *H. ovata*; the shellbark, *H. laciniosa*, and one or two varieties of the pignut, *H. glabra*; which, unlike the type of that species, are characterized by sweet kernels and thin shells. These species will be discussed in the order of their pomological importance.

The hickories, including the pecan and the shellbarks, as well as those species of no pomological value, have their male and female flowers together with the leaves upon growing wood; that is, they are all developed from one bud within the season of blossoming. The male flowers are in slender, three-parted catkins, or tassels, that are borne at the base of the shoot below the leaves or in the axils of the lower leaves. The female flower consists of a calyx, including the ovary; from two to four or more of these are clustered in a short spike near the end of the shoot. The fruit becomes lateral on the shoot through the prolongation of the terminal buds. Some observers (see Appleton's American Encyclopedia) have thought the pecan to have its male catkins from buds near the summit of the shoots of the preceding year, instead of being, as in the other hickories, from the base of the shoot of the same season. We have carefully examined the growth and blooming of many pecan trees, and find that while many such buds produce one or oftener a pair of three-parted male catkins, yet these were axillary on a suppressed limb growth, the center of the bud showing plainly that some injury had destroyed it, though the staminate buds under the first set of bud scales retained vitality enough to insure a weak growth. The normal growth of the catkins on a healthy shoot proves this view correct and shows that on successive nodes, somewhat closer together than those of most other hickories, the pecan bears from one to three sets of three-parted male catkins in pairs. In planting the pecan near the northern limit of successful culture, it seems worth the effort to plant with it the more hardy hickories, in the hope of securing a more timely, if not a larger, supply of potent pollen.

PECAN (*Hicoria pecan* Britton; *Carya olivæformis* Nuttall).

The pecan is found native in the United States on the river bottoms of an obliquely set area, having near its four extremities the cities of Davenport, Iowa; Chattanooga, Tenn.; Laredo, Tex.; and the region of the head waters of the Colorado River of Texas. From Davenport to Chattanooga the northeastern boundary of this area is quite irregular, the growth extending much farther north in the valleys of the larger tributaries of the Mississippi and Ohio rivers than in the intervening higher land. A few specimens are found as far up the Ohio as Covington, Ky. From Chattanooga to a point on the Rio Grande below Laredo, the boundary is also irregular, reaching but a short distance south into Alabama in the valley of the Tennessee, then skirting the easterly edge of the Mississippi River bottoms to Vicksburg, below which point the tree is not found native along the Mississippi. From Vicksburg across to the Rio Grande the pecan shuns the alluvial lands near the Gulf which are subject to long-continued overflow. It does not reach the Gulf at any point, but is often found within 75 miles of the coast, while in the valley of the Rio Grande it is not found within 100 miles of the Gulf. The Mexican district is here adjacent to that of the United States and extends an unknown distance up the Salado, a tributary of the Rio Grande, and farther into the interior. From the mouth of the Salado, the southern limit in the United States, to the head waters of the Colorado of Texas, the boundary is not definitely known. Thence back to Davenport it is comparatively direct, though fringed out toward the north where it crosses the streams. The tree shows its most thrifty growth in the rich black soil of the river banks in this area. It is found in irregular, open groves and strips of woodland, bordering the streams and moist lands, on slight elevations not long nor often inundated. Its abundance varies from a few scattered trees on some of the river farms to groves of several thousand trees on others.

It is reported to do well on rich soil, both wet and dry, whether high or low, stiff clay or porous sand, although best in rich, alluvial, creek and river bottoms. When not crowded by other trees the pecan attains great size. Single trees are reported 4 feet in diameter, and 70 feet in spread of limbs. Robert Ridgway, of the Smithsonian Institution, has photographs of very large forest pecan trees growing on either side of the Wabash River. One on the Illinois side of the river in Wabash County is 16 feet in circumference above the swell; another on the Indiana side is 30 feet in circumference at the ground and 18½ feet in girth above the swell, with a height of 50 feet to the lowest limb. Mr. Ridgway says: "The pecan tree is the largest of the hickories, and one of the largest trees of the forest. With the single exception of the white elm the pecan tree has the most widely expanded head of any tree, in proportion to its size; while in altitude and majestic appearance, the largest and finest elms are no comparison to it. The dome-like head may occasionally be seen reared conspicuously above the surrounding tree tops, some trees being as much as 175 feet high with a spread of 100 feet or more. The trunk, like that of the shagbark hickories, *Hicoria ovata* and *H. laciniosa*, is very long, often measuring more than 50 feet and occasionally 80 or 90 feet to the first limb."

VARIATIONS IN SIZE OF TREE AND IN SIZE AND QUALITY OF FRUIT.

The largest trees are reported upon the northeastern area of its native growth. But the largest and thinnest shelled nuts have been received from Mississippi, Louisiana, and Texas. R. C. Koerber, a large dealer in pecans in New York City, who has personal knowledge of the tree and its habit in Texas, says: "The largest and best pecans come from Louisiana. They reach the market earlier than do those from Texas and are of large size, measuring from 1¾ to 2 inches in length by three-quarters of an inch in diameter, in the middle. The quantity marketed from this State, however, is very limited. "In Bee County and adjacent territory in Texas

pecans are grown with very thin shells that may be crushed in the fingers; in Victoria County the more common pecan is large and round; in San Saba and Llano counties the pecan nut is large and the meat is plump, shell moderately thin."

The Texas pecan crop affords a large income for the inhabitants of some portions of the State, mainly in certain counties within the area named above. As early as 1871 it was reported from some of the cotton-growing sections of Texas that the pecan crop would be worth five times as much as the cotton crop of that year. Says Mr. Koerber: "But for this industry of nut gathering, the people of some localities must have starved for lack of remunerative labor. Hundreds of both white and colored people go out with horses and wagons to gather these nuts." Charles Mohr found that in 1880 there were marketed in San Antonio, Tex., the most important center of the pecan trade, over 1,250,000 pounds of nuts. The price paid by the wagonload varied from 5 to 6 cents per pound.

The best pecans of the State are produced in San Saba, Brown, and McCulloch counties and along the Concho and Guadalupe rivers and a few other streams. By the expression "best pecans" growers understand large nuts with thin shells. The Texas pecans vary greatly in size, but are generally egg-shaped, about 1 to 1½ inches long by one-half to five-eighths inch in diameter. On the bottom lands of southern Illinois, though the trees usually ripen their fruit, the nuts are smaller and less rich in oil than those grown farther south. They are said to keep better, not becoming rancid as soon as the more oily nuts. Of all the hickory family the pecan seems most susceptible of improvement in the size and quality of its fruit, and marked improvements by selection have already been made by several planters.

EXTENT OF CULTIVATION.

Sargeant¹ quotes Brendel, that "The pecan does not seem to have been known on the Atlantic Seaboard before 1762, when some of the nuts were carried to New York by fur traders from the Mississippi Valley. In 1772 William Prince planted 30 nuts and succeeded in raising 10 plants, 8 of which he sold in England for 10 guineas each."

The pecan has been planted very generally in collections of nut trees as far north as New York, west to the Missouri River, and also in California. In 1871, 150 trees were planted in Hinds County, Miss., by George Whitfield, and since that time orchard planting of this nut has increased rapidly, especially during the last six years. The largest planters of the pecan making reports to this division are F. A. Swinden, Brownwood, Tex., who has 400 acres planted with 11,000 trees. These are 40 feet apart each way and were in January, 1892, 2, 3, and 4 years old. Large nuts with soft shells were selected and planted where trees were to grow. He has cultivated cotton, corn, and alfalfa in this orchard, and expressed himself much gratified with the growth of the trees in 1890, notwithstanding the fact that he harvested from the same ground 110 bales of cotton, 300 tons of alfalfa, and 1,500 bushels of corn. At the close of the season of 1891 Mr. Swinden contributed further of his experience: "I soon found out that the yellow pine stakes I had put by each hill where the nuts were planted were attacked by the wood louse, and these made their way to the nut and eventually to the taproot, and thus killed the trees with their depredations. I lost nearly half of the trees I had put out. I removed the yellow pine stakes and put cedar stubs about a foot high in their place; but these, too, had to be taken away, as the rabbits fairly cleaned up the balance of the trees by gnawing them to the ground in the winter. These trees never did come up again. I began again and this time made a box crate 18 inches high of cypress wood and tarred the bottoms, and this ended my trouble with the wood louse and the rabbit. The first year, while they grow in the boxes, they must be closely watched to keep spiders or any other web insect from webbing in the boxes. During the second and third years the bud worm works into the terminal bud

¹ Silva of North America, Vol. VII, page 140.

in the early spring and kills it. To get rid of the bud worm I sprayed the trees with a solution of london purple and paris green. For the last three years I had the same land planted in cotton, corn, and alfalfa, which have been quite a source of revenue to me; but this fall I will have to plow out the alfalfa on account of detracting so much moisture from the ground; it would eventually kill the trees no matter if you were to dig 10 feet around them. I have lost some 300 or 400 trees that were planted in the alfalfa, but not a single tree in corn or cotton."

Louis Biediger, Idlewild, Tex.: "I have 500 trees, each grown from nuts planted of the varieties 'Biediger,' 'Giant,' and 'Idlewild.' These were planted where the trees were to stand, and they are not yet of bearing age."

E. S. Peters, Calvert, Tex., has 500 cultivated trees.

The estate of W. R. Stuart, of Ocean Springs, Miss., has 100 bearing trees in cultivation and 500 trees from 1 to 8 years old, of which a part are choice grafted varieties.

H. S. Kedney, of Winter Park, Fla., has an orchard of 4,000 trees, covering 100 acres, near the town of Monticello. His varieties are of the class called "Mexican papershell," a general term applied to several distinct varieties of nuts. They were grafted in Texas to the order of Mr. Kedney. To secure the 4,000 trees, about double that many seedlings were worked. They were all grafted at the age of 1 year in nursery rows, when the seedlings were about 8 or 10 inches high. The stocks were cut off just below the surface of the ground and split in the center; into these clefts the grafts were set in January and were well waxed. When the grafts had completed one year's growth the young trees were shipped from Texas to Florida, the grafts being then about 6 or 7 inches in length. They made but little growth the first year after transplanting. Mr. Kedney chose for his orchard the richest piece of land he could find in the State—a chocolate-colored hammock with red clay near the surface, and well drained. He has cultivated them as the orange is cultivated in Florida. After five years' growth (the orchard was set in February, 1887) these trees ranged from 6 to 20 feet in height. Mr. Kedney has experienced no particular trouble in maintaining his trees in a fairly thrifty condition; the twig girdler has done some damage, but this he endeavors to hold in check by gathering the fallen twigs in the winter and burning them.

Numerous other plantings of pecans have been made in Florida, mainly of seedling trees. The groves range in area from a very few acres to some of over 200 acres. Throughout all the Southern States there has been great interest for several years in planting this tree, and the aggregate of acres that promise to become permanently productive is very large. Along the northern limit of native distribution the plantings range from a few trees to a few acres each. An orchard of 150 trees, about 7 years old, at Federalsburg, Md., shows thrifty growth. The trees were planted about 32 feet apart each way. The ground between the rows has been planted each year with potatoes, beans, and tomatoes. The soil is the light, sandy loam of the Maryland Peninsula, with a yellow-clay and sand subsoil. Several persons in Delaware are growing a few trees, which are doing well, but have not reached bearing age. W. F. Causey, of Milford, Del., has a fine tree in bearing; he says its annual product for several years has been one or more bushels. In Illinois there have been planted groves of from 15 to 25 acres. In Ohio a planted tree is reported at Lebanon 70 years old, and bearing good crops. At Dansville, N. Y., D. W. Babcock reports 40 or 50 4-year-old trees making satisfactory growth. Robert Manning, of Salem, Mass., has a promising tree, grown from a nut sent him from Illinois. In contrast, he writes that all seedlings from Texas nuts have winterkilled with him as fast as grown. At Martinez, Cal., is an orchard of 600 pecan trees on the farm of the late Richard J. Strentzel. Many other persons in California report plantings of a few trees each.

AREA PROBABLY ADAPTED TO PECAN CULTURE.

It is perhaps too soon to judge accurately how far the area of its growth may be extended northward with any certainty of producing profitable crops, owing to the fact that the trees are found to make a very satisfactory growth in latitudes where the male and female blossoms fail to bloom at the same time, and consequently fail to set fruit.

B. F. Johnson, of Champaign, Ill., who has given some attention to the subject, says: "There will be a host of disappointed ones if many try to grow the pecan for fruit north of 38°. It succeeds best south of 35°. Like osage orange and honey locust, the pecan loves the moist bottoms of rivers, and bears fairly well on the Illinois River as far north as 40°. But the pecan, like the English [Persian] walnut, *Juglans regia*, withstands the low temperature of a northern latitude and grows to a fairly good size much farther north than it will produce fruit. In northern California the English [Persian] walnut is barren, although having complete and healthy flowers, because of the unequal development in point of time of the female and the male blossoms; the former develop, dry up, and fall off before the male blossoms are mature." A similar inequality of development of the male and female blossoms is, he thinks, responsible for the barrenness of a pecan tree of his own planting, which, though blooming full yearly for the last five or six years, has failed to yield more than a few dozen inferior nuts. Similar conditions in the case of other species of fruits and nuts suggest the possibility of furnishing a pollen supply at the proper time by setting an occasional tree of either the shagbark or shellbark hickory in the pecan orchard where the fruit is not intended for reproducing pecan trees. Plantings now made will probably demonstrate how far north pecan culture can be made profitable. Present indications are that there is a possibility of success in favored localities as far north as the Mason and Dixon line, extending across the country as far as the southwest corner of Ohio and thence northwest to Davenport, Iowa. The lines of extension of pecan culture toward the north and west will be mainly up the rivers that flow into the region of natural growth. The outlook for the pecan in California is very encouraging. The California Fruit Grower reports that at a meeting of the State Horticultural Society, December, 1890, pecans from the farm of Mr. Wolfskill, at Winters, were exhibited. This exhibition was followed by a discussion on "pecan growing for profit." George Husmann said that, in his opinion, there are pecan trees of both sexes, and that this accounts for the fact that many trees raised from seed do not bear nuts. On this account it was advised that trees be always budded or grafted with varieties that are known to bear regular crops of large, well-shaped nuts. Gustav Eisen spoke of pecan trees growing near the Merced River which had attained a height of 60 feet. E. J. Wickson thought this the only species of the hickory family worth experimenting with in California, all other species having proved almost valueless. Fred C. Niles noted an instance of the successful culture of the "Eastern hickory nut at an elevation of 3,000 feet."

DICECEOUS VARIETIES.

There is a widespread belief that some varieties of pecan are diceceous. Mr. Husmann's statement, noted above, is supported by the evidence of certain expert axmen of Texas, by whom some pecan trees are designated as "he," or male, trees and these persons say that such trees never bear nuts. It has also been observed that when supplied with abundance of pollen from adjacent trees certain other pecan trees regularly produce an abundance of full-meated nuts; but later, when the other pecan trees are cut down, the solitary tree bears only occasional crops of nuts, always hollow, without meat.

POMOLOGICAL IMPORTANCE OF THE PECAN.

This is scarcely less than that of the Persian walnut or almond at the present time. With an area of special adaptation in the United States considerably larger than is found for either of the others, and with a susceptibility to improvement by selection, in size of nut, thinness of shell, and delicacy of flavor that are very encouraging to those who have attempted this work, the pecan is probably destined to become the leading nut of the American market. If its culture is pushed with the usual skill and energy of American enterprise, there is reason to believe that it will not be many years before the pecan will become not only an abundant nut in our markets, but also an important article of export.

CHANGING PECAN FORESTS TO PECAN ORCHARDS.

Numerous efforts have been made to clear up native groves by cutting out trees of inferior pecans and other timber, leaving good pecan trees as thick as they ought to stand for good crops. A trustworthy opinion of the results of these efforts can hardly be formed yet. On the Guadalupe River in Texas, a grove of this sort, comprising 480 acres of well-drained land, produced in 1885 about \$2,000 worth of nuts and in 1886 did equally well. This is reported as one of the most profitable groves of this character. There are many thousand acres of pecan trees along Texas river bottoms which have been offered for sale at from \$3 to \$10 per acre, and in occasional years the profit per acre from the nuts has been greater than could have been made from raising the usual half bale of cotton; but frequently there have been two or three successive failures in the nut crops, and owners prefer the more certain and more constant returns of a cultivated crop, so the trees are sold for fuel and the land is put under the plow.

The Gazette, of Fort Worth, Tex., says: "The cost of converting land liable to overflow, into a pecan grove would be so small as to scarcely deserve a name. There is no need of clearing it up. Line out rows among the wild growth of the bottom, and at each point where the pecan tree should stand, clear off a space 8 to 10 feet around, and in the center dig a hole, say, 18 inches deep. Scrape into this hole surface soil till filled, then plant three or four nuts 3 inches deep and tread on the hill to pack the covering a little. This completes the job. It is well to notice the lean of adjacent trees. If when cut away they would unavoidably fall upon the young tree, it might be best to cut them away at once. No other trees need to be disturbed, as their shade will be more advantageous than otherwise. The after culture of the new grove will be extremely simple. Make a run of the rows once or twice during the season, and destroy the encroaching weeds. When the young trees springing from the nuts seem to be established, cut away the weaker specimens, leaving only the best specimen in the hill. Nothing additional will be needed. A few years later, when the young pecans are getting well up, you can commence cutting out the crowding growths for firewood. This operation can be continued from year to year until the pecan trees are large enough to occupy the ground alone—there will be nothing left in the way. No other clearing is at all necessary, not even the removal of the brush left by the cutaway growths—it remaining on the ground to rot and mingle with the soil will prove a decided advantage to pecan groves."

PROPAGATION.

Until very recently the propagation of pecan trees has been entirely confined to the growing of seedlings from selected nuts. Where this method is pursued it is best to select nuts of good size, having thin shells and plump kernels, from trees known to be vigorous and productive. Some growers have claimed that the improved varieties come true from the seed and have deprecated other modes of propagation as likely to lessen the vigor of the tree. The evidence thus far presented, however, indicates that

the improved pecans are as variable in their seedlings as other fruit trees and can not be depended on to reproduce themselves from seed.

B. M. Young, of Morgan City, La., sends us numerous specimen nuts grown from seed which came from a single tree that stood at least one-fourth of a mile from any other bearing tree. These nuts show a wide variation, none of them being alike, nor like the nuts from the parent tree.

On plate 8, fig. 10, will be found an illustration of a large pecan grown in San Saba County, Tex. Fig. 11 of the same plate shows a seedling from it grown in the same county. The grower, who formerly depended upon seedlings for planting, now advocates budded trees. Though selected seed is more likely to produce trees bearing superior nuts, than is seed taken at random, the only sure way of increasing a desired type is evidently by some method of bud propagation.

Cuttings.—Pecan cuttings callus when stored in damp sawdust, and it is probable that in a damp climate, such as that of Mississippi and Louisiana, the tree may be propagated in this way. When the lateral roots of the pecan are broken by the plow the ends of these roots frequently send up thrifty shoots; so the suggestion has been made that it could be propagated by cutting the slender roots of trees known to bear choice nuts, and raising the cut ends nearly to the surface, fixing them there until leaves and branches are developed from adventitious buds.

Layering.—Reports from Texas state that in 1886 some large, bearing pecan trees were blown down; a number of their lateral roots remained unbroken and in place under ground. The trees so fell that large limbs were bent and split and broken by contact with the ground. The fractured pieces were driven a foot or more into the wet soil. The limbs projecting above the fracture, and also other limbs of the trees, have since borne nuts. In these cases digging down under the fractures has disclosed new roots. This would indicate that propagation could be effected by layering. For the increase of some specially choice variety this method may be worth the trial.

Allied stocks.—At the threshold of propagation, we are met with the question: Is there no stock other than ordinary pecan that will insure a healthy growth of bud or graft of this nut, and that will give more lateral and fibrous roots and insure more dwarfish growth of the top?

The pecan will form a healthy union with any of the hickories, and possibly some strain of the lower-growing sorts may be found that will give good results. One of the possibilities in this line is the re-discovery of a dwarf pecan which is believed to be in existence somewhere in the South. In 1853 John LeConte presented before the Academy of Natural Sciences of Philadelphia a unique pecan which he named *Hicoria Texana*, and of which he said the habit was to grow 10 or 12 feet high. By letters to numerous correspondents and by inquiries through newspapers in the South we have endeavored to secure specimens of it, but have not yet succeeded in locating a tree of the species. Some nuts (pl. 12, fig. 7) sent to the Department by W. R. Stuart in December, 1890, from some unremembered correspondent of his in Texas, are probably identical with LeConte's *Texana* of 1853. Mr. LeConte says of *H. Texana*: "This species of *Hicoria*, which I found cultivated in Georgia, is a native of the State of Texas. The small altitude it attains, the later period of its foliation, and the very different form of the nut readily distinguish it from every other hitherto described. The tree is about 10 feet high, leaves 13 inches long, frequently rather over than under this measurement, with a terminal one on a rather long petiole; leaflets lanceolate, acuminate, the lower ones more convex on the upper than the lower edge, dentate on the upper edge from about one-third of the distance from the base; the lower edge is almost entire, except a few small teeth near the point. The terminal leaflet is dentate on both edges, but not near the base; nut somewhat ovate, pointed at the upper extremity, less so at the lower, flattened, somewhat rough and slightly angled; one-fourth inch long, 1 inch broad. It differs from *H. olivæformis*, or common pecan [now

Hicoria pecan] in being a much smaller tree, seldom being more than 10 or 12 feet high while the other frequently reaches to 80 or 90 feet; in the smaller size of the leaves, which rarely exceed 14 inches in length, the leaflets being 4 or 5 inches long, while *H. pecan* has leaves from 19 to 20 inches long and leaflets 7 inches; but most peculiarly in the shape of the nut; this, in our species, is ovate, flattened, although protuberant on the sides, and rough; in the other very smooth, cylindrical, pointed at each end. The leaves of *H. olivæformis* [*pecan*] are fully formed before this species shows the least sign of foliation."

Budding and grafting.—Reports received from many correspondents who have been experimenting in the propagation of the pecan indicate that annular or ring budding, root grafting, and cleft grafting at the collar have been the most successful. Shield budding, the cleft grafting of branches, diagonal side or wedge grafting, such as is practiced on the orange in Florida, while occasionally successful, are not to be relied on in common practice.

Annular, or ring, budding.—Jules Fonta, New Orleans, La., says: "In June and July, when young seedlings are very sappy, we take off a ring of bark about three-fourths of an inch long from the nursery stock to be budded and replace it with a ring cut from a branch of equal size on the tree to be propagated, and tie to keep out rain. This is the best way to propagate pecans in this climate."

John Keller, Ocean Springs, Miss., writes: "After a series of experiments, I think less than 40 per cent of grafts set in branches will grow, and a large proportion of those set in the stump close to the bulge of the roots will succeed, and 90 per cent of buds set by annular budding may be expected to grow."

E. E. Risien, San Saba, Tex., writes: "I have attempted to propagate the pecan by budding small seedling trees near the ground the second and third year. Experiments were successful to a degree better than grafting with me."

Mr. Risien has practiced for some years a method of annular top budding of large trees with very satisfactory results. His method consists in cutting back established trees, either self-grown or planted, in the early spring just as the sap begins to rise. This causes a large number of vigorous shoots to be pushed out from dormant or adventitious buds below the point of cutting back. The development of these shoots is aided by hacking the old, rough bark of the stubbed limbs and trunk with a hatchet. When the shoots have reached the size of an ordinary lead pencil, June 15 to July 15 in his locality, they are ready for budding. Scions of the season's growth are cut from the tree that is to be propagated, using special care to secure such as are of the same size as the shoots to be budded. Only such buds as are found on smooth, round wood are suitable, and of these each scion yields but one or two, commonly near the base. The budding is done by the "annular" or "ring" method described on page 13. Mr. Risien states that he chooses dry days for doing this work, and has better success when several dry days follow the operation than when rainy weather occurs. He places special stress upon careful wrapping and "tying in" of the bud, and prefers for this purpose strips of old cotton cloth, as being less likely to cut into the tender and fast-growing shoots. These shoots are headed back to within a few inches of the bud, and the remaining portion of the shoot is entirely cut away by the time the bud is 1 year old. In about two weeks after budding the ties should be cut. The buds soon push, if conditions are favorable, and must be tied to an older branch or other support to protect them from being broken by hard winds. (See pl. 3.)

Grafting at the collar.—J. D. Husted, Vineyard, Ga., writes: "In clearing new land I save hickory trees that are 2 or 3 inches in diameter, cleft graft at or near the surface as soon as buds begin to swell and before the bark starts. I cover the entire graft with earth, so that it will not dry out at the union."

John G. Kline, Buckner, Ky.: "I have been successful in grafting on hickory near the surface, and hilling up to exclude air from the graft."

W. R. Stuart, Ocean Springs, Miss.: "I whip-grafted below the ground last winter; very successful."

N. B. Howard, Clarcona, Fla.: "I have grafted the pecan with common cleft graft several feet from the ground; about 20 per cent succeeded. Many started well but wilted and died. I am satisfied they were sucked by the soldier bugs. [Probably either *Rhaphigaster* or *Euthoctha*.] It does considerable damage here. I have since covered grafts with mosquito netting with success."

James Mott, Orlando, Fla.: "We cleft graft at the collar on native hickory and cover with earth, or if above ground we use ordinary grafting wax."

Root grafting.—B. O. Curtis, Paris, Ill.: "I get stocks of seed from Knox County, Ind., from which I grow for the trade. I graft 5 or 6 inches of scion on 4 inches of root. They have lived and done well. I have done this two seasons."

W. Sigerson, Ocean Springs, Miss.: "A neighbor has had success with seedlings from seed bed, cut back and cleft grafted same as apple or pear."

E. E. Risien, San Saba, Tex.: "We can, by the aid of a damp cellar, with the temperature near 50°, succeed in grafting seedling trees of the first year's growth by tongue grafting. Both root and scion must be exactly the same size to make these little trees. We need but 6 or 8 inches of the root; neither use any wax in tying. I bury these in layers of clean river sand where they can get strong light (no sun); after we are quite sure the union is complete and new roots are forming, plant separately in pots and remove them in a week or so to a shady place. Water freely. This furnishes nice little grafted trees for shipping by mail, but, as the percentage of these that live is so small, the price will, I fear, always be high."

J. H. Girardeau, Monticello, Fla.: "I put in about 1,000 grafts in all, but found that only those in which I had used the top half of the seedling root [as stock] lived. I cut the seedling root, when long, into 2 and sometimes 3 pieces, and grafted each piece. I find on close examination that only in one or two instances the lower sections united with the scion. I used the ordinary splice graft. About 350 lived out of about 500 top sections of root. One unfortunate mistake I made was in fertilizing with cotton-seed; this invited the wood-lice, and these destroyed fully one-half of all that had lived."

Top grafting.—Successful top working by other methods than annular budding, either on pecan or other hickories as stocks, is reported by a few experimenters.

Owen Albright, Leesburg, Fla.: "With a wedge graft, cutting in diagonally; also by splitting. I bud any time, and have grafted in July with new wood, cutting diagonally and leaving the top on until healed in. Have had success all these ways."

Frank White, Live Oak, Fla.: "With cleft graft on young hickory. I use common grafting wax and cover the waxed portion with cloth. Over three-fourths of them grew."

Dudley W. Adams, Tangerine, Fla.: "By cleft, side, or wedge graft. Quite successful; growth rapid and strong. Grafts 4 years old 4 inches in diameter." A. V. Chubbs, Pensacola, Fla.: "I succeed with bud on wild hickory. I have 1,000 thrifty young trees."

Orchard vs. nursery.—Whether to plant nuts where trees are to grow or to transplant from the nursery is a disputed question among pecan growers. S. M. James, of Mound, La., favors the former method and gives the following directions: "Put the rows 60 feet apart and plant the nuts 4 or 5 inches deep, driving pieces of shingle around the nuts to protect them and to mark the spot. The planting may be done any time before the 1st of April, but the earlier the better. All the land, the row planted in pecans included, should be planted in cotton and well worked. In the fall following germination put down a post by the side of each plant, and about 4 inches from it, and square in the cotton row; this will be a protection to the trees in after years. The post will turn the mule and plow and prevent the pecan from being injured. Plow the row well that the pecans are planted on, and see that

no weeds shade them and that the cotton does not come nearer than 3 feet to them. A tree at 2 years old will be ten times larger where it has been carefully plowed than where it has been left to itself. All trees that I manured showed the effects within a few months, and these effects are visible to-day. The first winter after they are planted the rabbits will bite them off as smooth as if a knife had cut them; but this biting by the rabbits does no serious harm, for in the spring they send up a vigorous shoot from just below the cut, and by that fall they are too large for the rabbits to bother. The trees should stand about 60 by 60 feet, or 12 trees to the acre. They will give a moderate crop in fifteen years, and in twenty years they will be in full bearing."

Charles Mohr says: "Place several nuts after their harvesting, in each hill, well supplied with rotted manure. The next season the strongest seedlings are left standing. The hills should be at least 50 feet apart each way." The late W. R. Stuart, of Ocean Springs, Miss.: "When at all practicable, plant the nut where you wish the tree to stand. If grown in nursery, cut the taproot at 1 year old, so as to get all the fibrous roots possible. The main thing is to make no mistakes in the beginning, and to see that trees planted are produced only from large, choice seed."

Nursery method.—George Tyng, of Victoria, Tex., says: "The fullest successes I have seen have been attained by treating the pecan absolutely as a fruit tree from seed to harvest. No more costly mistakes have I made than in trying to follow nature in raising the pecan. Every agricultural success has been achieved by overcoming nature's efforts to defeat it."

Most operators favor planting nuts as fresh as possible. When these are bedded in boxes of sand, sunken in the earth, and ashes are mixed with the sand as directed in the introductory chapter of this treatise, the result will be very generally satisfactory. Pecans that have become dry have been made to germinate quite well if they are soaked in cold water for one or two days before planting, and afterwards are kept in a moderately moist bed. In early spring the sprouted nuts are taken from the seed bed and are carefully planted in well-prepared nursery rows. The rows should be about 4 feet apart to allow convenient working with horse and cultivator, with the seedlings set at 8 inches apart in the row. They will thus shade each other from the hot sun. Open the furrows for the nuts only so fast as to leave the earth fresh and moist for planting, and be sure to make the earth very firm around each nut after it is properly set. Finish with a garden rake, carefully placing a thin layer of loose earth over that which has been packed about the nuts; this will prevent the crusting of the soil that will otherwise occur. In about ten days, by a careful working with narrow hoes, the surface of the earth should be loosened to the depth of half an inch on either side of the nursery row. For the rest of the season cultivate well, keeping the ground level and clean. With the pecan, as with most other nuts, some propagators follow the practice of transplanting the trees at the end of the season for the first two or three years. Their theory is that trees come into bearing sooner if they are removed once or twice before the final planting. They can show beyond question an increase of surface roots, and they claim also to modify the rampant growth of the top. At each removal care is exercised to save 10 to 12 inches of the main taproot and all the laterals. Where roots are severed the cuts should be smooth and without ragged edges. The same things may perhaps be more cheaply accomplished by the root pruning referred to on page 11.

Mr. Tyng says: "Much stress has been laid upon the taproot in transplanting young pecan trees, and to avoid the injury to that precious root, experts have recommended planting the seeds in places where the trees are to permanently stand. I swallowed that rank nonsense, with a lot more of pecan lore like it. All nut seedlings make, the first year, a taproot three to five or six times as long as their sprout. I have seen thousands of nut trees grubbed out of canal and railroad excavations or uprooted

by streams, and but few trees over a few years old had any taproot whatever. Yet occasionally I have found large pecan trees with heavy taproot growth, and some of these go down into permanent water. A smooth cutting of this root does not injure young trees, but does induce the multiplying of other roots. In this part of Texas a costly experience has taught me some of the objections to planting seed nuts in places where trees ought to stand. During the winter mice and other vermin dig up the nuts. In the spring, as soon as the nuts begin to open, they attract the ants, which eat out the kernels or so much of them as not to leave enough for the healthy growth of the sprout. When the sprouts appear above ground, crows pull them up as greedily as they do corn. Then rabbits gnaw all the sprouts from which the crows have been driven; and if the little trees had escaped all these dangers, it costs far more to cultivate them in orchards than it does in nurseries for the first three years. In the early spring of 1889 I planted about 6,000 healthy sprouting nuts. I doubt if there are now living 600 trees from them, or if they average as well in size and thrift as any 600 of over 6,000 of my transplanted trees one year younger."

It is desirable to protect the tender bark of the seedling from the scalding effects of the sun during the first summer, and this is effected by planting quite close in the rows, and by making the rows run northeast and southwest. In transplanting pecan trees, the roots should be carefully protected from injurious action of light, which is sometimes done by a wrapping of moss, but is more cheaply and efficiently done by plunging the roots into a tub of thin mud.

SOIL.

The best soil is a rich and deep alluvium, moist, but not wet, nor holding surface water. The pecan will grow, however, in any land that has not compact clay subsoil and that does not hold the water near the surface. Charles Mohr, of Alabama, says that satisfactory development of the tree may be insured on lands of poor, light soil, and the production of nuts of good quality secured by annual mulching and manuring. He further says: "The pecan shuns a dry, silicious soil, and the attempts to raise it on sandy, rolling, pine lands have resulted in disappointment; the highly porous soil rendering the application of fertilizers of little benefit to the tree. It fails also on lands with a rocky subsoil, which impedes the growth of the taproot."

Mr. Tyng says: "The river bottoms are the natural habitat of the pecan, but they are also the natural habitat of all the pecan enemies in the shape of disease, insects, vermin, crowding vegetation, and excessive water. The finest and most productive trees I have seen have been raised on well-drained upland, distant from the haunts of their enemies."

The most rapid growth and earliest fruiting of ungrafted pecans have been on sandy land; the grandest trees and most prolific bearers have been on rich river bottoms. There can be no doubt that the pecan orchards of the future will be on well-drained, tillable land, though it may be a thrifty use to make of some less favorable locations.

TRANSPLANTING.

The holes should be large and deep; a quantity of surface soil mixed with a little compost should be thrown in about the extremities of the roots to give the young tree a good start. In Delaware the successful transplanting of pecan trees and other nut trees 6 to 10 feet high with few surface roots has been made with the aid of a few potatoes thrown into the hole when planting. In the southern half of the United States, fall is the best time for planting trees, soon after the leaves fall, usually from November 1 to December 15. Planting can also be done in the spring, from February 1 until the buds begin to swell. Mr. Tyng writes: "Theory makes us transplant when the trees are dormant, and with tops cut back freely. But as a fact my most successful transplanting was made in summer and without trimming tops or roots." It is probable that careful work, moist soil, and cloudy weather are more important than season or

pruning. Failure appears due to a neglect to pack the earth closely around the roots, but chiefly to exposing the roots too long to strong light, and particularly to not setting the tree as deep as it grew in the nursery, thereby exposing to sunlight the collar and crown of the roots.

Of a lot of grafted and budded pecans sent in February, 1892, from Mississippi to Texas, Mr. Tyng had the best results in transplanting with those whose taproots had been cut in 1891, and which had been grafted near the crown. These all made thrifty growth. The ring-budded trees came next in order of success, while those having long taproots, and especially where the young tree was grafted some distance from the ground, a very large proportion failed to start at all.

CULTIVATION.

This should be thorough during the first three years, or until the trees are of good size. Cultivate as for the cotton crop and keep the grass and weeds from around the trees by hoeing or mulching. Trees thus cultivated in Mississippi that are 13 years old have grown to be 1 foot in diameter and yield from a barrel to a barrel and a half of nuts annually. Other trees of the same age and not cultivated are but 4 inches in diameter. To secure the best results, manure, care, and cultivation must be bestowed upon the trees.

FERTILIZERS.

Good, well-rotted stable manure, ground bone, old bones crushed, or cotton seed make acceptable fertilizers. A mixture of well-rotted stable manure and pure bone meal has given excellent results.

DISTANCE.

Most cultivators agree that pecan trees should not be planted less than 40 feet apart, and on strong soil a distance of 60 feet would be better. A young grove at Morgan City, La., planted 50 feet apart, has branches intermingling and the owner, B. M. Young, regrets they were not planted 100 feet apart.

Mr. Tyng, of Texas, holds to the opposite practice of planting close together, or at most only a medium distance apart, and thus writes: "Prune back to pollards and you get the largest proportion of new wood to a given area of ground, because trees can thus be set closer together, and the pecan produces its fruit only on new wood. Some writers assert that the pecan will not stand such pruning; those writers never tried to prune pecan sprouts out of a cotton field. Such experiments as I have been able to make appear to show that the pecan tree can be pruned or trained to any shape desired, whether low, spreading, pollard, or even flat espalier. I do not know how it can be dwarfed, but hope to learn."

AGE OF BEARING AND THE YIELD.

The pecan occasionally bears a few nuts at an early age. A tree on the plantation of H. J. Huck, at Austin, Tex., bore two perfect nuts at 2 years old from the seed; others have borne at 5 years old. Nuts are often borne at 6 or 7 years of age, but a paying crop can not be expected at an earlier age than 10 years under the most favorable circumstances. The crops usually increase until the tree arrives at full bearing at the age of 20, 30, or 40 years. The tree grows rapidly, reaching a height of from 20 to 25 feet within ten years. Trees 3 years old, when taken from a nursery in 1873, began to bear in the garden of Charles Mohr six years later, and the crop of less than half a bushel in 1883 has increased steadily until 1890, when it was $2\frac{1}{2}$ bushels of nuts of a quality that would command 15 cents per pound. Another tree in his immediate neighborhood, from a nut planted in 1867 and left undisturbed, now has a girth of 66 inches and yields from $3\frac{1}{2}$ to 4 bushels of nuts of a high grade, commanding a price of 20 cents per pound.

The annual crop of a tree in full bearing is variously reported as from 1 to 20 bushels.

HARVESTING.

When the orchards that are now growing come into profitable bearing, some cheaper and quicker method will need to be devised for gathering the crops. F. A. Swinden, of Brownwood, Tex., as noted on page 19, thinks he will be able to successfully operate a street sweeper in his large orchard, and, running to the straight lines of the trees, brush the nuts into rows. If the ground is rolled hard and smooth before harvest this may work satisfactorily, but there is yet room for inventive skill. Heretofore, methods of gathering have been quite primitive even to the cutting down of trees in the forests to secure their crops. The story of killing the goose that laid the golden egg may have seemed like the fancy of an author's brain, but here is a condition of things that has long existed wherein the facts discount the fable.

Theorists insist that the best crops of nuts, especially for seed, are obtained with all nuts by letting the fruit remain until the natural conditions have fully ripened the crop and the fruit falls of its own accord. To pursue this practice makes harvesting tedious and marketing tardy. By this method the nuts are picked up from the ground every morning after they begin to fall. They are spread in lofts or other dry places to cure, and are then packed in sacks, barrels, or boxes for market. The only curing that many crops of pecans get is in sacks or barrels while awaiting marketing. The usual method of harvesting is to watch the trees in the fall, and as the hulls begin to open, shake the trees or thresh them with long, light poles like fishing rods. The nuts rattle down upon the ground and are picked up into baskets. Nuts that fail to leave the hull on striking the ground are cleaned by hand or tossed into a heap on some grassy mound and threshed from the hull with rods. The thinner-shelled pecans are often broken by such beating. The dealers in pecan districts buy, either by the bushel or the pound, such nuts as gatherers take to the town, at from \$1 to \$4.50 per bushel, according to the size and quality. About half the reports indicate the pound as the unit of measure, and place the price per pound at from 8 to 10 cents. A bushel of pecans is rated in some reports at 44 pounds and in others at 50 pounds. A barrel of pecans varies in different reports from 100 to 120 pounds.

In Texas the legal weight of a bushel of these nuts is 44 pounds, which some correspondents think is too heavy by at least 2 pounds for perfectly dried nuts.

CLEANSING AND POLISHING.

After the nuts are hulled or "shucked," they are placed by some harvesters in revolving churns where, by turning, they are cleaned and brightened. Others bleach the nuts with sulphur fumes, but this practice is objectionable and should be discouraged. An industry was established a few years since at Austin, Tex., by R. C. Koerber, for cleansing and polishing or "burnishing" pecans, a business which he has since transferred to New York City. Convenient establishments for cleansing the nuts in the neighborhood of the orchards will be the demand of the near future. A good assorting screen and dirt separator at every important center of gathering is a desirable adjunct to this business. Mr. Koerber's enterprise has added materially to the popularity of the pecan as a dessert nut, and indicates one direction for effort in broadening the market.

MARKETING.

Between the grower and the consumer of pecans there are several handlings of the nut, and not a few intermediate dealers and merchants. The gathered nuts are of three classes, namely, those grown from selected stocks for planting, those for confectionery and dessert uses, and those suitable only for making oil. Pecans

for seed are in good demand at the present time, owing to the general interest felt by planters within the probable area of its successful culture. With a confidence that amounts to enthusiasm on the part of propagators, it is a matter of no surprise that the price of choice pecans has been materially enhanced by the increased demands. For planting, the more popular-named varieties readily sold in the fall of 1891 and 1892 at from 50 cents to \$1.50 per pound. The trade in these nuts is mainly done by orders through the mails, much the same as the retail trade in seeds and nursery business is carried on, and to a great extent by the same persons.

DESSERT PECANS.

As a nut the pecan has for about a century been deservedly popular because of the thinness of its shell, from which the large, full kernel is easily removed, and because of the agreeable flavor and wholesome quality of its meat. A Frenchman named De Courset, who served with Washington in 1782, left the record that "that celebrated general always had his pockets full of these nuts, and that he was continually eating them."

For dessert and confectionery purposes the nuts commonly found in the markets are much smaller than those selected for seed. It is doubtful if many pecans of named varieties have yet been sold for other than seed purposes, owing to the scarcity of the choice varieties and the demand for them at high prices for planting. Of the proportion of pecans that are consumed for dessert purposes as compared with other nuts we have not been able to secure satisfactory data. The demand is believed to be steadily increasing, and the pecan seems to be supplanting other nuts for many uses.

PECAN MEATS.

The industry of preparing the kernels, or meats, of pecans for market, though yet in its infancy, has assumed large proportions. It was begun by Mr. Koerber in 1884, and his books show that in 1887 he prepared 20,000 pounds, and in 1890 more than 100,000 pounds. Formerly very few confectioners used pecan meats, being unwilling to take the trouble to crack the nuts and pick them out. With a machine especially constructed for cracking these nuts Mr. Koerber finds that pecan meats are coming into general use. He thinks it will be but a short time before nut meats will replace the whole nuts on hotel tables. Three pounds of nuts contain about 1 pound of meats. Pecan meats in halves sell at 45 to 50 cents per pound. Smaller pieces of pecan meat sell at a lower price.

NUT OIL.

Louis Biediger writes: "As far as I know the small pecans have been sold every year at from 2 to 3 cents per pound and sometimes as low as three-fourths to 1 cent per pound. They are used for oil. I do not know the methods or the machinery used, but I believe the process is much the same as that used for peanuts. I think it would pay to establish mills to use up small pecans. I do not know the uses to which it could be put, but I believe it would be first-class oil for table use. It would probably be too expensive for illuminating, although for the latter purpose anyone can satisfy himself of its superior quality. A kernel when lighted will burn for some time and make a clear, brilliant light. Crushed with the shells on the mast will make acceptable hog feed, but the shells would be objectionable in the feed of neat cattle. If some means could be devised for removing the shells before expressing the oil, the mast would surpass either linseed or cotton-seed meal for feeding all animals. It would be more healthful to milch cows and its flavor would materially improve the butter."

ENEMIES OF THE PECAN.

The principal enemies of the pecan tree, in order of their importance, are exposure to light, water-soaked soil, insects, vermin, and disease. A correspondent in Texas says the Guadalupe River bottom is full of pecan trees of all ages and in all stages of destruction by an excess of water backed up into the soil, occasioned by the choking of the drainage channels. The wood lice get into young trees under the forks of the roots and gradually check or destroy their growth. Caterpillars consume their foliage at times to such an extent as to destroy the crop. Worms get into the young fruit and the "Sawyer" beetle cuts off trees and branches of considerable size. All of these pests, as well as crows and vermin and pecan diseases, are more abundant in the bottoms than in the uplands. After the nuts are formed, and while their stems are still tender, an undescribed insect is reported in Texas as cutting large quantities from the trees. So far as is yet determined the nutlets do not contain the larvæ of this insect, nor are the young nuts eaten, but the stems are cut and the nuts fall to the ground. In the latter part of May of some years, the terminal buds and tender growth of nursery stock and orchard trees are much damaged in that State by a "minute worm," which is thought by growers to be the larvæ of a fly which infests the trees. These flies are in turn kept in check by numerous small spiders which prey upon them.

Experimenters report that so far as they have tried the arsenical poisons they seem to damage pecan trees. Buhach and hellebore keep the fly from the buds without damage to the tree, but these are too costly except for small trees of special value. In California, pecan trees have been attacked and greatly damaged by the cotton cushion scale of the orange, but the Australian Ladybird (*Vedalia cardinalis*), imported for destroying the orange insect, has cleaned up the pecan trees as perfectly as it saved the orange trees. The fall web worm (*Hyphantria cunea*, Drury) damages the pecan tree by destroying many of its leaves, and weaves unsightly webs among the foliage. A spraying of paris green or london purple is a safe and sure remedy. Some planters destroy these webs and the worms in them by burning a tuft of cotton or rag tied to the end of a pole and saturated with kerosene. The burning ball is held under the web but an instant. This is sufficient to destroy the worm and will not injure the young twigs of the tree. The caterpillar is hatched from eggs laid on the leaves by a small, common whitish moth spotted with black or brown. The larvæ of *Cyrtene picta*, a black beetle about three-fourths of an inch long and spotted with bright yellow, is occasionally found in pecan trees. This beetle deposits eggs upon the bark of the tree early in the spring; in about ten days afterwards the eggs hatch and the young borers begin to cut their way through the bark and upward into the wood and trunk. When full grown, the larva is about half an inch long and resembles the peach-tree borer, though its head is not so broad and flat. *Oncideres cingulatus*, a twig girdler, is a grayish brown beetle about three-fourths of an inch in length that is mischievous in the pecan tree. The female of this insect pierces the twig and after depositing her eggs therein descends a few inches and girdles the twig round and round with her beak until it is almost cut off. The larvæ that hatch from the eggs work along the pith of the twigs and by fall are ready to go into the ground for winter quarters. By the high fall winds these girdled twigs are readily broken off and carried to the ground, with their insect tenants unharmed. The remedy recommended has been to gather and burn the twigs as they fall.

TWIG BLIGHT.

Twig blight of the pecan has been found by a correspondent of the Gazette of Fort Worth, Tex., invariably springing from swampy or soggy land. Occasional overflows of streams rather help than injure the growth of this tree, but lands permanently swampy or soggy are unfavorable. The trouble shows first on the slender twigs, and is called "pecan blight." Immediate and thorough drainage is the remedy.

NAMED VARIETIES.

Propagators of choice pecans have named some of their best varieties, and by careful selection are endeavoring to fix the types they have selected, either by bud propagation or by growing selected seedlings. It may be well to repeat here the qualities that are regarded most desirable in selecting pecans for planting or for propagating in other ways. They are: First, large size and plump kernel. Thirty-three to thirty-five large pecan nuts are contained in a pound; of medium-sized ones there are about fifty to the pound. Second, choice quality; a nut of but small size may be worthy of propagation if it has high quality and a thin shell. Third, thin shell. Fourth, early maturity of fruit and productiveness of tree. A dwarfish habit of growth is also desirable.

When choice pecans are to be propagated from seed the greatest care should be exercised to guard against the deteriorating influence of pollen from inferior varieties. Evil effects may be feared even from the presence of other species of hickory in the neighborhood, as natural hybrids between the pecan and other hickories are not infrequently found. Choice varieties should have appropriate names applied to them before being introduced to the general public or put on sale. The same rules should be observed in selecting names as are followed in naming fruits. There has been little concerted action in this regard, but with a view to avoiding future confusion it is to be hoped no more "paper-shells" or "eggshells" will be put upon the market, especially with the prefix or suffix of the town, county, or State where grown. Some of the best varieties introduced are here described and illustrated:

BILOXI (pl. 8, fig. 13).—From the late W. R. Stuart, Ocean Springs, Miss. A very thin-shelled nut of second size and quality, and a large amount of red, corky growth in partition walls of nut.

CENTENNIAL (pl. 9, fig. 8).—From Richard Frotscher, New Orleans, La. A large oblong nut; thickness of shell medium; considerable red, corky growth in partition walls; kernel plump, oily, good.

FAUST (pl. 9, figs. 3 and 4).—From O. D. Faust, Bamberg, S. C. A long, quite large nut, well worthy of propagation.

FROTSCHER (pl. 9, fig. 5).—From Richard Frotscher, New Orleans, La. Size large; shell very thin; kernel quite oily; quality good.

IDLEWILD (pl. 9, fig. 2).—From Louis Biediger, Idlewild, Tex. This is a choice nut, of recent introduction; quality good; shell rather thick.

—— (pl. 8, fig. 15).—A seedling, unnamed, from B. M. Young, Morgan City, La. Size medium; shell thin; quality good.

JEWETT (pl. 9, fig. 12).—From the late W. R. Stuart, Ocean Springs, Miss. A large oblong nut, somewhat angular, compressed near the center of most specimens; thickness of shell medium; corky inner growth considerable; quality very good.

JUMBO (pl. 9, fig. 7).—From F. M. Ramsey, Bluffton, Tex. A very fine, large, ovoid nut, with quite thin shell, but having a good deal of red, corky growth in the partition walls; quality excellent.

MCCALLISTER (Synonym: *Floyd*) (pl. 9, fig. 6).—Received from O. L. McCallister, Mount Vernon, Ind. This is probably a hybrid. It is the largest nut among all the hickories received at this office. The hull is about one-fourth of an inch thick when dry, and opens readily to the base with four valves. Nut $2\frac{1}{8}$ inches long, $1\frac{5}{16}$ inches wide, and $1\frac{1}{16}$ inches thick; base broad, rounded; apex broad, blunt, angular. In compressed form, in color of nut, also in the angularity and thickness of shell, it is quite similar to shellbark hickory. The kernel of a well-filled specimen is in color, consistency, and flavor more like a shellbark of high quality than a pecan. The tree is reported to be "so similar to pecan in bark and leaf that it would be impossible to detect the difference," yet the buds and young wood more closely resemble shellbark. The tree was found many years ago on a farm now owned by Mr. McCallister; the

nuts have little pomological value, as grown on the original tree some years, the kernel being shriveled and not filling more than one-third of the space within the shell, yet nuts from the crop of 1893 have been received at the Division of Pomology which were well filled with a kernel of very pleasant flavor. Possibly it may become more uniform in maturing fruit in Mississippi or Texas, where the season is longer than in Indiana. It is well worth a trial by experimenters in those States. Sargent¹ gives a short description of this nut under the name Floyd, and accredits the points of his description to A. S. Fuller in New York Tribune, weekly edition, July 9, 1892, and says it is perhaps a hybrid.

MAMMOTH (pl. 9, fig. 10).—From Richard Frotscher, New Orleans, La. One of the largest pecans; oblong in form; shell thick; quality good.

PEARL (pl. 9, fig. 1).—Received from T. V. Munson, Denison, Tex., who had received it from E. E. Risien, of San Saba, Tex. This is one of the smaller nuts, but is especially commendable for its thin shell, sweet kernel, compact partition walls, and the absence of the acrid inside corky growth often found in the wild nut. In the last respect it is the best nut received at this office. Its small size ($1\frac{5}{8}$ inches long by five-eighths to three-fourths of an inch broad, and requiring 100 to weigh a pound) will limit its planting to amateur collections, as it is too small to find favor in the general market.

POST (pl. 8, fig. 12).—From Herbert Post, Forth Worth, Tex. An oblong, square-ended nut, with moderately thin shell; inner corky growth quite abundant; kernel plump, oily, and of very good quality. Herbert Post explains that "the Post select pecans are grown by a man by the name of Post, in the southwestern part of the State. How many trees of that variety I don't know. The particular tree from which those came I sent your Department is in a cotton field, and receives cultivation along with the cotton every year."

RISIEN (pl. 8, fig. 14).—From E. E. Risien, San Saba, Tex. A very large nut of good quality.

SAN SABA.—From E. E. Risien, San Saba, Tex. Size medium; form cylindrical, compressed near apex; base roundish, slightly conical; apex obtuse-conical, compressed on two sides; weight about one-fifth ounce; surface quite regular; color light yellowish, striped and spattered with purple from the hull; shell moderately thin, quite firm; cracking qualities very good; kernel very plump, light yellow, with yellowish-white meat; flavor sweet, rich, pleasant; quality very good. The original tree stands near the junction of the San Saba and Colorado rivers, and has been under observation for many years. It is reported to bear annual crops. Mr. Risien has propagated the variety by top working large, wild pecan trees, and by root grafting small seedlings.

STUART (pl. 9, fig. 11; also pl. 1).—From the late W. R. Stuart, Ocean Springs, Miss. One of the largest pecans; 35 nuts to the pound; ovoid in form; shell very thin, with considerable red corky growth in partition walls; kernel plump; quality good.

VAN DEMAN (pl. 9, fig. 9).—From the late W. R. Stuart, Ocean Springs, Miss. A large nut; 45 weigh a pound; oblong in form; shell quite thin; considerable red inner growth; kernel not as plump as Stuart; flavor excellent.

Besides the varieties described above, a number of others have been named and propagated by the following parties: Louis Biediger, Idlewild, Tex., Biediger, Briden, Giant, and Graff. T. V. Munson, Denison, Tex., is propagating the Gonzales, a pecan from Gonzales County, Tex. Arthur Brown, of Bagdad, Fla., is growing varieties of his own naming, as follows: Alba, Turkey Egg, Georgia Melon, Black Jack, Ribera, Favorita, Longfellow, Repton, Helen Harcourt, and Petite. Ladd Bros., of Stonewall, Miss., report Mexican Papershell, Excelsior, Valsies, and Texas Egg.

¹Silva of North America, Vol. VII, page 158.

THE SHELLBARKS.

Under this head come the two species, *Hicoria ovata*, commonly known as the Shagbark, and *Hicoria laciniosa*, the Shellbark. The name shellbark comes from the peculiar rough, shaggy bark which characterizes the trunks and larger branches of trees of these species after they reach the age of about 10 years. This and the very thick hulls surrounding the nuts are noticeable characteristics of the two species. They can hardly be classed among cultivated nuts, though both species have for many years been planted in collections of nut-bearing trees. There is yet standing at Bedford Park Station, on the Harlem Railroad, in New York City, a row of trees of the shagbark, planted as nuts by Andrew Corsa¹ at the close of the Revolution. Numerous other instances of attempts at growing these trees for timber and nuts are also on record, but from a pomological standpoint the successes have been few. One of the chief causes of failure has been the tendency of seedlings grown from choice nuts to deteriorate, and the difficulty experienced in perpetuating occasional improved types. It has been found that a very large proportion of the seedlings grown from choice nuts are inferior to the seed planted. And when an occasional choice variety has been secured the ordinary modes of bud propagation have failed to increase its stock. In view of the numerous superior wild types, especially of *Hicoria ovata*, that have been brought to light recently, and a better understanding of the methods of propagation suited to the hickory, there seems to be reasonable ground for the belief that by selection, cultivation, and careful propagation there may yet be produced varieties bearing good crops of thin-shelled nuts, possessing superior cracking qualities and good flavor.

GRAFTING THE HICKORY.

The methods, the skill, and the care necessary in grafting the shellbarks and other Northern hickories are the same as for the pecan. In the answers we have received the failures and partial successes each number about as many as the satisfactory results reported. Florida and Georgia growers have been among those most successful with the cleft graft. They have used the more common hickories for stocks upon which to propagate choice pecans. By some, grafting was done at the surface of the ground, and by others at several feet above the ground. In Illinois Benjamin Buckman has been successful with crown-cleft graft in early spring. In New Jersey inarching has been more successful than either cleft grafting or slip grafting with Charles Parry, of Parry, while William J. Logan, of Summerville, gets satisfactory results from ring budding. In Ohio C. W. Faust, of Canton, and the late Leo Wertz, of Wilmington, have reported success either to graft or bud "the same as for apple." In Pennsylvania Charles C. West, of Milan, has "found the ordinary top grafting successful;" Davison Greenwalt, of Chambersburg, says: "The only way I ever succeeded was by cutting off the young trees close to the ground, and cleft grafting, waxing, and covering up the scion to the top with earth." By directions from this office many hickory and pecan grafts were set early in the spring of 1891 at different points in the United States by the method last described, and, so far as learned, the results were generally satisfactory.

SHAGBARK (*Hicoria ovata* Britton; *Carya alba* Nuttall).

(Synonyms: Little Shagbark, Little Shellbark, White Shellbark, White Walnut.)

This species is found native from southern Maine westward across Canada, Michigan, Wisconsin, and southeastern Minnesota; southward (although sparingly) through eastern Nebraska, Kansas, Indian Territory, and Texas; and eastward across Missis-

¹ Grandfather of Andrew Corsa, mentioned on page 39.

issippi, Alabama, Georgia, and northern Florida. The outer bark of the tree breaks at varying angles into broad, thick layers or strips which remain attached to the trunk sometimes by either edge, sometimes by the top or bottom, and stand out from the body presenting a very shaggy appearance. The leaves of this species have five to seven leaflets, in two or three pairs with serrate edges, tapering to a sharp point, with a terminal leaflet of the same general character. The hull surrounding the nut is very thick and the four sections of which it is composed separate freely from tip to base. The nut is angular with a hard though thin shell, and in form varies from long ovate to quadrangular. (See pl. 10, figs. 1-4.) The kernel is plump, sweet, and delicious, and in many cases parts readily into halves, free from the shell, under a moderate hammer stroke upon the edge of the nut. A like result is obtained by the ordinary simple nutcracker. This cracking quality is one of its most desirable points from a commercial standpoint, as it makes possible at a moderate expense the placing on the market of this excellent fruit, in an attractive form, for use by the confectioner, or as a "nut-meat" for dessert.

Yield and price.—The age of beginning bearing ranges in the various reports from 5 to 30 years. There are very few reports of profitable crops, although it is believed that when choice varieties are cultivated this will not be the case. The annual yield of trees in full bearing ranges in reports from one-eighth of a bushel to 40 bushels. Where the reports have placed the yield of the hickory at from 20 to 40 bushels they probably refer to nuts in the hull, but we lack definite replies on this point. The price per bushel at place of harvesting, as reported, ranges from 20 cents to \$3. Throughout New England and the Middle States, where the shagbark is most abundant, few farmers protect nut-bearing trees. The nuts are in most places free to children, and relatively few are sold. In the central Western States the price of the shagbark is from 75 cents to \$1 per bushel for the smaller nuts, and \$1.25 to \$2 for the finer sorts. In Wisconsin hickory nuts sell at \$1 per bushel of 40 pounds.

Choice shagbarks.—Though not many have been propagated except by seed, many variations showing superior size, thinness of shell, good cracking quality, plumpness and quality of kernel, have been noticed in different parts of the country. Almost without exception they belong to this species. The naturalist, Michaux, who wrote on this subject in the early years of this century, mentions a variety of this nut that he saw on a farm in "Seacocus, near Snake Hill," N. J., with fruit nearly twice as large as that of the species, and having a white shell with rounded prominences instead of angles. A century of cultivation, he says, would perhaps not advance the species generally to an equal degree of perfection with this accidental variety. Careful inquiry fails to disclose any more recent information concerning this tree. It was probably destroyed before its value became generally recognized.

Correspondents report as follows: Edwin Hoyt, New Canaan, Conn.: "We find some very good-sized nuts that would be profitable if grafted in groves."

A. J. Coe, Meriden, Conn., sends a nut (pl. 10, fig. 4). Medium size, compressed, obovate; rather smooth shell, of medium thickness; cracking quality, good; flavor, rich. Mr. Coe says of it: "A large tree, very productive; of high flavor."

George H. Ayres, Allamuchy, N. J.: "I have a variety with thin shell, kernel free, and of good flavor."

G. S. Snyder, Middleburg, Pa.: "We have some that are nearly the size of walnuts."

John D. Souder, Telford, Pa.: "I have 50 trees of small shellbark that yield 100 bushels annually."

R. B. Clark, Fay, Pa.: "I have rich, sweet nuts, rather small in size, from a tree 1 foot in diameter. It is a good annual bearer."

Emory A. Pryor, Akron, Ohio, sends some rather small ovate nuts that have thin shells, crack well, and yield good kernels in perfect halves. (See pl. 10, fig. 1.)

William Pryor, Cuyahoga Falls, Ohio, sends a nut of medium size and quality, which we have illustrated (pl. 10, fig. 3), as the quadrangular type of this species.

A. C. Harvey, La Fayette, Ind., sends specimens of a long, pointed, ovate nut deeply grooved and with a rather heavy shell. It is of good flavor and is illustrated as a form often found in this species. (See pl. 10, fig. 2.)

S. Lee Cox, Oakwood, Ill., has a variety of good size and of good cracking qualities.

W. S. Rhea, Pulaski, Tenn., has a large, long, angular, ovate nut of rather thick shell, fair cracking quality, and large, rich meat.

J. N. Harris, Griffin, Ga.: "I have some few almost equal to pecans."

NAMED VARIETIES.

Until the investigation preliminary to the publication of this report but few shagbarks had received varietal names. The difficulties and disappointments attending propagation have cooled the ambition of the most enthusiastic owners of choice hickories, which may be accredited for the short list of varieties named.

CURTIS.—Received from A. J. Coe, Meriden, Conn. A medium-sized, smooth nut, slightly compressed; shell thin, cracking quality excellent, kernel plump and light colored; quality good.

DOVER.—Specimens from Andrew Stough, Dover, Pa. Size, medium or below medium; quite angular, broader at the base than toward apex, with a distinguishing long and sharp point at the base; color, dull yellowish; shell moderately thin; cracking qualities medium; quality moderately good, with slight astringency.

ELIOT.—Grown by Whitney Eliot, North Haven, Conn. This variety was brought to public notice by being awarded a prize offered by A. J. Coe for the best hickory nut exhibited at the December meeting of the Connecticut Agricultural Society, 1892. It is a nut of medium size, compressed, angular, ovate in form, with a large and prominent tip. The shell and inner partitions are thin and the cracking quality good, though not best; kernel plump, not very oily; flavor mild and pleasant. Is the product of a grafted tree.

HALES (*Hales' Papershell*).—Specimens from Henry Hales, Ridgewood, N. J. Large, quadrangular, somewhat compressed, quite angular and "lumpy" in external appearance; brownish tinge; shell is thin, but does not check well to the ends in cracking; kernel is deeply corrugated, but leaves the shell easily, and is of fair quality. The tree is large and bears a fair crop annually; it is growing with several others of the same species on the farm of Mr. Hales. Its propagation in a small way has been attempted with some measure of success. This nut seems to have been the first variety to receive a distinctive name. About 1870 Andrew S. Fuller described it under the name "*Hales' Papershell*."¹

IDEAL.—George J. Streator, Garrettsville, Ohio. A compressed, quadrangular nut of medium size; shell moderately thick and too deeply corrugated internally to admit the easy removal of the meat, which is moderately plump and of good quality.

JACKSON (pl. 10, fig. 7).—J. F. Rice, Berlin Cross Roads, Ohio. A large, smooth, compressed oval nut, with moderately thin shell and large, plump meat; cracking quality medium; quality of meat excellent.

LEAMING.—Rush G. Leaming, Sedalia, Mo. A large nut of fine flavor and very good cracking qualities, the meat coming out freely in uninjured halves.

MERIDEN (pl. 10, fig. 6).—A. J. Coe, Meriden, Conn. Large, compressed, almost ob-ovate; shell rather thick, but cracks well and has a large meat; quality good.

MILFORD (pl. 10, fig. 8).—O. C. Cook, Milford, Mass. A medium to large compressed ovate nut, with thin shell, superior cracking quality, plump meat, and excellent flavor; one of the best.

RICE (pl. 10, fig. 9).—J. F. Rice, Berlin Cross Roads, Ohio. Medium to large, angular, ovate; shell thin, cracks well; meat plump, light colored, and of fine quality. Mr. Rice reports that the tree hardly ever fails of a good crop.

¹ Practical Forestry, 1884, page 120.

SHINAR (pl. 10, fig. 5).—Samuel C. Moon, Morrisville, Pa. Medium size, irregular, ovate; thin shell; rather poor cracking quality; meat tough, but of good quality.

WOODBOURNE (pl. 10, fig. 10).—Samuel C. Moon, Morrisville, Pa. Large, smooth, long, compressed, ovate; shell rather thick, but cracks very well; meat tender, rich, and of best quality.

SHELLBARK (*Hicoria laciniosa* Sargent; *Carya sulcata* Nuttall).

(Synonyms: Big Shellbark, Thick Shellbark, Bottom Shellbark, Big Shagbark, River Bottom Hickory, King Nut.)

The bark on trees of this species resembles that of *H. ovata*, but the strips or flakes are very long and narrow, thinner, more divided, and of a lighter color than those of *H. ovata*. The leaflets number from seven to nine, arranged in three or four pairs with one terminal. The leaflets are pointed and have serrate edges. The hull inclosing the nut is very thick and disproportioned to the size of the nut.

The four parts separate freely to the base. The shell of the nut is much thicker than that of *H. ovata*. The kernel often fails to fill the inner spaces of the shell, and instead of being plump, often presents a shrunken appearance. This species occurs in Genesee Valley, New York; also in Chester, Bucks, and Huntingdon counties, Pennsylvania; west across Ohio, Indiana, Illinois, southeastern Michigan, southwestern Wisconsin, southeastern Minnesota, Iowa, southeastern Nebraska, eastern Kansas, and Indian Territory, eastward to the eastern foot of the Alleghanies; in bottom land and low rich soil; rare and local, being most common and reaching its greatest development along the streams of southern Kansas and Missouri, Arkansas, and Indian Territory. The wood is used for the same purposes as that of the Shagbark hickory. The large nuts are sweet and edible, and under the name of king nut are sold in the markets of western New York, being harvested in the valley of Genesee River. Perhaps the most that can be said of this species is that many of the nuts are marketed; but until specimens are found of thinner shell and fuller kernel than most of those we have investigated, there seems little incentive to plant them for their fruit. The prices at which the nuts of this species are sold to dealers range from 20 cents to \$1 per bushel. Plate 11 represents some characteristic forms of *H. laciniosa*. In this species a nearly round form will be occasionally found (fig. 2), while the oval (fig. 3), quadrangular (fig. 1), and long ovate (fig. 4) forms are as marked in this species as in that of *H. ovata*, with modifications even more numerous.

From H. M. Engle, Marietta, Pa., we have received specimens of a very promising nut which probably belongs in this species. Size, $1\frac{1}{2}$ inches long, $1\frac{3}{16}$ inches wide, seven-eighths inch thick; shell bright, from one-sixteenth to one-eighth inch thick; cracking qualities good; kernel plump, a little tough, moderately free from shell, quite good.

OTHER HICKORIES.

MOCKER NUT (*Hicoria alba* Britton; *Carya tomentosa* Nuttall).

(Synonyms: Black Hickory, Bull Nut, Big Bud Hickory, White Heart Hickory.)

This species is closely allied to the shellbarks by its flowers, leaves, thick hull parting to the base, and the sweet kernel of its nuts. Its bark, however, is not disposed to scale as do the shellbarks. The foliage is very pubescent and odorous; leaflets 7 to 9, rarely 5. The hull is not so thick as that of the shellbarks, but the shell is thicker and harder. (Pl. 12, figs. 3b, 1a, 2a, 3a.) In average size, the nut is between the two shellbarks. The shape is roundish oval, often tapering to a sharp point. (See pl. 12, figs. 1-3.) The kernel is small, very sweet, and generally of a yellowish color. Its growth is reported in the Tenth United States Census of Forestry "generally on rich upland and on hillsides, less commonly in low river bottom lands; very common in the Gulf States and throughout the South, the most widely distributed species of the genus." It is not a promising nut because of its thick shell and small kernel.

PIG NUT (*Hicoria glabra* Britton; *Carya porcina* Nuttall).

(Synonyms: Brown Hickory, Switchbud Hickory, Bitter Hickory, Broom Hickory.)

Bark close. Leaflets 5 to 9. In form the nut is without angles, generally compressed, sometimes roundish, sometimes pear-shaped, and often depressed at the tip. (Pl. 12, figs. 4-6.) The kernel is generally small and as a rule is bitter and unedible. The involucre or hull of the nut is thin, not splitting freely to the base. It grows on hills and uplands from southern Maine to Florida, westward to Minnesota, eastern Nebraska, and Texas. There are trees of this species, however, that yield nuts having plump, sweet kernels and thin shells. One such is illustrated in pl. 12, fig. 4. It was sent to the Department by G. B. Brackett, of Denmark, Iowa, in whose honor we have named it *Brackett*. He wrote under date of November 1, 1890: "The nuts are a wonderful example of what nature is doing, unaided by man, in the development of higher forms from lower. In this case perfection has been reached in reducing the thickness of the shell to a minimum." The nuts of this variety are above medium in size, smooth, without angles, and are compressed at the sides and at the base, and are of grayish-white color. The shell is very thin, so that with two in the hand the shell of one or both is readily crushed with pressure. The kernel is large and full, and in flavor resembles closely *H. ovata*, but in color of surface is more like the bitternut, *H. minima*. In cracking it separates readily into halves clear from the shell.

C. S. Sargent adds two botanical varieties, *H. glabra*, var. *odorata*, and *H. glabra*, var. *villosa*.¹ The former agrees with *Hicoria microcarpa* Britton; *Carya microcarpa* Nuttall. The latter is common on dry, flinty hills in the neighborhood of Allenton, Mo., and has remarkably small buds.

NUTMEG HICKORY (*Hicoria myristicæformis* Britton; *Carya myristicæformis* Nuttall).

This is a close-barked tree that grows in small areas of South Carolina and in the valley of the Arkansas River. The hull is somewhat rough. The nut is smooth and lined with streaks of white, in form and color resembling the nutmeg, but the specimens we have seen are much smaller. The shell is extremely thick and the kernel correspondingly small and valueless though sweet.

BITTERNUT (*Hicoria minima* Britton; *Carya amara* Nuttall).

(Synonyms: Swamp Hickory, Sprignut [local].)

Bark close. Leaflets 7 to 9, ovate, lanceolate, minutely glandular, pubescent beneath. Britton says the leaflets of this species are generally smaller at maturity than those of any other Northern species, and to this fact he thinks the name *Minima* was intended to apply. The hull is thin, and like *H. glabra* separates but about halfway down the nut instead of in four distinct valves. The shell is thin, so that in some cases it may easily be crushed with the fingers. The kernel is very bitter and valueless. It grows on borders of streams and in swamps, often on rich uplands.

WATER HICKORY (*Hicoria aquatica* Britton; *Carya aquatica* Nuttall).

(Synonyms: Swamp Hickory, Bitter Pecan.)

This tree grows in the low river swamps; it is most common and reaches its greatest development in the bottom lands of the Lower Mississippi and Yazoo rivers. Leaflets 7 to 13, narrow, and pointed at the apex, margins unequal, slightly pubescent below. The nut is thin-shelled, angular, rough; of a dirty-brown color and ugly in appearance. (Pl. 12, fig. 8.) The kernel is more bitter than that of *H. minima*. Of no value unless for use as a stock on which to graft the pecan.

¹ Silva North America, Vol. VII, page 167.

THE HAZELS.

(Corylus L.)

The hazel, or filbert, as the nuts of the various species of the genus *Corylus* are somewhat indiscriminately designated, is of all nut-bearing trees the one best suited to garden culture. Six species produce nuts, of more or less value, and of these one attains the height and dimensions of a forest tree, the others being under ordinary conditions only bushes or shrubs. Three of these species are native to the United States: the American hazel (*Corylus Americana*), the Beaked hazel (*Corylus rostrata*), both widely distributed, and the California hazel (*Corylus Californica*), found on the Pacific Coast. The European hazel (*Corylus avellana*) and Lambert's Filbert (*Corylus tubulosa*) are widely grown in Europe, and these with their varieties and crosses yield the nuts of commerce. The Constantinople hazel (*Corylus Colurna*) is the strongest grower and its seedlings are used as stocks on which to graft the others. Its nuts are small and of little value.

In general the hazels may be described as large shrubs or low trees with deciduous, alternate, simple leaves. All are unisexual, having the staminate blossoms in catkins, developed in the axils of the leaves, on the wood growth of the previous year. The catkins are visible as early as August of the previous season, and in March or April the pollen is freely scattered. The pistillate blossoms compose a star-like tuft of crimson stigmas projecting beyond the short, scaly bud, the inner scales of which keep pace with the growth of the enlarging pistils so as to nearly or wholly inclose it at maturity. The pistillate blossoms sometimes bloom later in spring than the staminate ones on the same bush, and in such cases it is necessary to supply pollen from other sources, at the proper time, to secure a crop of nuts. This the European growers accomplish by hanging twigs of staminate flowers, collected from the wild hazel, on the upper branches of the trees in their hazel orchards when the bright crimson of the pistillate blossoms begins to show. No doubt the same purpose could be accomplished by planting an occasional wild tree of a selected pollen-producing strain in the orchard.

The attempts at cultivation of the hazels in this country seem to have been confined chiefly to the European varieties and to have been in the main unsuccessful. The causes of failure have not been clearly established, and from the fact that what has hitherto been attempted has been done in a desultory way, and that but little definite record has been left concerning experiments, renewed efforts seem to be needed in the introduction of this nut. In portions of Washington State climatic conditions seem almost identical with those that prevail in England, and the introduction and trial there of the best varieties is certainly worthy of encouragement. The following discussion of methods of culture and varieties of European hazels is mainly compiled from English works upon that subject:

• EUROPEAN HAZELS (*Corylus avellana* L.; *Corylus tubulosa* Willd.).

There has been much confusion among European writers as to the species to which different cultivated varieties of the hazel belong. It may well be doubted, in fact, whether there is not now in most of those varieties such a blending of character as will render specific distinction impossible. In general it may be said that the true filberts are classed under *C. tubulosa* and comprise those varieties having oblong nuts with thick shells surrounded by a husk that is longer than the nut, while the cobnuts or simple "nuts," as they are often called, are round, usually smaller than the filberts, and are borne in short, open husks. These are classed under *C. avellana*.

This classification agrees with that observed in the markets, where short, round nuts are known as cobnuts, and oblong ones as filberts. But as both forms of nuts may be found in both styles of involucre it can only be used by botanists under protest

till a more satisfactory classification can be made. Several foreign writers at various times have undertaken the systematic arrangement of the cultivated hazels. Dochnal¹ based his classification on botanical characters. For characteristics of the various groups he used, first, the size and shape of the fruit and the shield (i. e., that part of the surface of the base of the shell which was connected with the husk); second, thickness of shell; third, characteristics of the kernel and its covering; fourth, the size and shape of the husk; fifth, the stipules. Under his third grouping Dochnal maintained that the tortuous umbilical suture is a characteristic feature of *C. tubulosa*, and the direct suture is a characteristic of the forest hazel *C. avellana* and the "Zeller nusse" (cob nuts). This suture marking of the kernel was noticed by Pliny, but as a feature for distinguishing the different nuts, it seems since his time to have fallen into neglect.

Dr. Fingerhuth² states that in *Corylus tubulosa* (the long-fruited hazel) the suture turns toward the left in all cases, and in *Corylus avellana* it runs in a direct course from base to tip.

The umbilical suture may be noticed in the hazel by carefully crushing the shell and noting that on one side of the nut is a scale-like growth, curved from the base toward the tip of the kernel. Its center is thread like, but as hard as the shell, from which it is separated. Its width varies, with a greater or less amount of the corky inner growth of the shell remaining attached to it. Its elasticity resembles that of a metallic spring. Its position of growth in the shell is marked on the kernel by a depression. This depression is called the umbilical suture. It has been maintained by some authors that its position in the shell and the direction of its growth across the kernel is of much value in designating the different hazels.

Burchardt, after a series of observations, confirms Dochnal's statement that the position of the umbilical suture in *C. avellana* is different from that in *C. tubulosa*. In the former it runs from the center of the base, as from a placenta, directly toward the tip, turning neither right nor left. It generally runs along one side of the seam, sometimes in a direction differing from that of the seam. It is, however, never tortuous, but in all cases it runs directly from base to tip. In *C. tubulosa* the suture is always tortuous. That the turn of the suture is toward the left in all varieties of *C. tubulosa* is not admitted by Burchardt, and he contends that it can be shown that it curves toward the right as often as as it does toward the left.

Franz Goeschke³ divides the cultivated hazels of Europe into four groups. In Group I he places *Corylus avellana*, the forest hazels. Group II, an horticultural species which he designates *Corylus maxima* includes the zellernuts (cobnuts). Group III, *Corylus tubulosa*, comprises the filberts. Group IV, hybrid nuts, consists of crosses at variance in type with the first three groups.

Goeschke holds that the name "Lambert nusse," a name applied to *C. tubulosa*, was derived from Lombardy, in Italy, whence the nuts came. He claims that grafted hazels are more fruitful than trees derived from layers and suckers; that the hazel is a valuable addition to the flora of a section interested in bees, as it supplies an abundance of pollen very early in spring; that oil from the filbert is superior in quality to the best olive oil, and that the kernel of the hazel is equal to the almond for making nut cakes. Large quantities of nuts are peeled and fried in oil by the Italians, and are thus imported into Germany and sold as "noces."

Robert Hogg, pomological director of the Royal Horticultural Society of Great Britain, gives the following synopsis of nuts:⁴

"1. Nuts shorter than, or husk as long as the nut. Varieties: Bond, Cob, Cosford, Downton Square, Pearson's Prolific.

¹ Sure Guide in Pomology, Nuremburg, 1860.

² Journal Linnea, vol. 4, p. 384.

³ Die Hazelnuss, Berlin, 1887.

⁴ Fruit Manual, 1875.

"2. Filberts: Husk longer than nut. Varieties: Frizzled, Lambert's, Purple, Red, White."

For descriptions of these varieties see pages 73, 74.

PROPAGATION.

Propagation is effected by seed, by layers, by suckers, by cuttings, and by grafting or budding. Grown from suckers, trees come earliest into bearing, and by some are claimed to make the strongest trees; but the major portion of hazel trees produced in nurseries are from cuttings, made 8 or 10 inches in length, from last year's wood. They root as readily as gooseberries. A moist, not wet, sand supplies the best ground in which to root cuttings; a deeper setting is necessary in the drier climate of the United States than in England. In a year the cuttings become well rooted, and are then transplanted, after pruning, from the propagating bed to the nursery row. The nursery culture consists of thorough and frequent stirring of the surface soil, and the training of each plant to tree form. The sprouts and branches are kept removed from about the base to a height of 12 inches (the Germans claim that a height of from 3 to 4 feet for the trunk is better); within the next 6 or 8 inches the head is formed of not less than six branches. In the midst of these branches a barrel hoop is often placed, to which the limbs are tied for forming a shapely and open crown. The aim of the two or three years of nursery work is to grow the trees to 6 or 8 feet in height and in form like a goblet, after which they are ready for planting.

IN THE ORCHARD.

The hazel will not thrive in stiff clay, while in dry, sandy soil it becomes stunted and produces fruit of small size. Otherwise, the bush is not particular as regards soil and locality; it is always more vigorous on rich land than on poor land. A light loam with dry subsoil will give the least wood and most nuts. A strong soil produces an excessive growth of wood at the expense of the crops. Wet soils produce too much wood and too little fruit. In Kent, England, the hazel thrives best in limestone land, and reaches a height of 12 feet, and occasionally of 30 feet. The trees are set in well-drained ground, about 10 feet apart each way, though sometimes they are set in hedges, when a less distance in the row is adopted. Root pruning is frequently practiced to check the too-rapid growth of wood. The disposition of the hazel to make thrifty inside cane growth is kept constantly in check by summer pruning, and the outer limbs, together with the general growth of the tree, are checked by pruning back in the latter part of the winter. The thin, unfruitful twigs are removed and the fruitful limbs are shortened back nearly to the female buds. Care is taken to leave sufficient male catkins for an ample supply of pollen. The fruit spurs are near the extremities of the last year's growth, and nuts are more abundant where air and light have ready access. In the fifth or sixth year after planting, trees should bear considerable fruit. Trees of this age in England are reported to produce from 3 to 4 pounds of nuts each. It is a very important orchard tree, with many cultivators in Europe, and has been greatly improved by years of careful cultivation and selection. A very fruitful hazel orchard is reported in Wernfeld, Germany, occupying about $2\frac{1}{2}$ acres of land and having a northwesterly slope. In that latitude the trees are said to thrive with any exposure except directly southern. They are recommended by Goeschke for clothing the steep sides of hills and mountains; also for railroad banks. He states that in Germany they are advantageously used in those portions of fruit orchards where other trees fail.

HARVESTING AND MARKETING.

It is a popular method in England to harvest and market finer nuts in their husks. In all cases the fruit is left on the bush or tree until fully ripe, the proper condition being readily determined by the brown color of the nut, the tint of the husk, and the

readiness with which the nuts would rattle out by a slight jarring of the trees. In curing the nuts thus harvested, they are placed for a few days in lofts to sufficiently dry, after which they are packed in sound casks with a slight sprinkling of salt throughout the filling. Salt is also used in small quantities in storing the nuts that have been freed from husks, and it is claimed for this practice that freedom from ravages of insects is secured and that the nuts come out fresher and brighter than by other methods.

Generally, the hazel is marketed for dessert purposes alone, though a pleasant oil, resembling olive oil, is sometimes expressed from it; and in portions of Europe this nut, like the chestnut, has been used in limited quantities for making bread.

NOTES FROM CORRESPONDENTS.

Thomas Brigden, South Lowell, Ala.: "I believe the improved varieties of pecans, the Madeira and the English cobnut, will prove of great value here. The last two were among our most profitable crops in the south of England. They are easily propagated and require but little care or cultivation. The principal point in cobnut culture is the pruning. This must be done with a view to forming fruit-bearing spurs or twigs and preventing the growth of the rank switches. Within 10 miles of Maidstone in Kent, England, there are hundreds of acres of these nuts, yielding a heavy profit to the grower. I hope the nut question will be fully ventilated, for it is one of the farmer's money crops."

George W. Sutton, Perryville, Md., has three trees of the European hazel. Each tree has several branches or bodies from near the ground which have grown to the height of 25 or 30 feet. These trunks vary from 5 to 10 inches in diameter. The nuts produced are nearly round, with a caliber of about five-eighths of an inch. The shells are thin. (Pl. 13, fig. 7.) These trees are moderately prolific, though without culture, growing in a lawn. They were probably planted by a former owner of the property.

J. W. Killen, Felton, Del., is propagating a European sort that he has named "Jones." It grows as a shrub; is fruitful, hardy, disposed to sprout a good deal from the root. The foliage has thus far been free from mildew and other diseases in Kent County, Del. The nut is short, roundish, of medium size; quality good.

Josiah Prettyman, Smith, Del., has a tree of European filbert 17 feet high with a spread of boughs of 15 feet; the trunk is 25 inches in circumference at 1 foot above the ground. It was grown from a sprout that was planted when very small, in its present location, about twenty years ago. It has been pruned as peach trees are pruned in Delaware. The tree has had but little cultivation and no manure. It has borne nuts for several years. The nut is of medium size, oblong in form, broadened at the tip; shell rather thick; kernel plump, good. (Pl. 13, fig. 5.)

VARIETIES.

The named varieties are numerous, but the grower having a half dozen of the best can well afford to forego the planting of others. Of the ten varieties named by Robert Hogg¹ the Cob and Lambert are best known in reputation to Americans. We follow his description of the best varieties known to him:

BOND NUT.—Husk hairy, shorter than the nut; nut of medium size, ovate and oblong; shell thin; kernel large. This is an excellent nut, and the tree is a good bearer.

COB (*Round Cob*).—Husk hairy, shorter than the nut and much frizzled; nut large, obtusely ovate; shell of a light-brown color, rather thick; kernel large. A good nut for early use, but does not keep well.

¹ Fruit Manual, London, 1875.

COSFORD (*Miss Young's*).—Thin shelled; husk hairy, long as the nut and deeply cut; nut large, oblong; shell of a light-brown color, very thin, so much so as to be easily broken between the finger and thumb; kernel large and well flavored. An excellent early nut, and the tree an abundant bearer.

DOWNTON SQUARE.—Husk smooth, shorter than the nut; nut large, short, four-sided; shell thick; kernel full and well flavored.

FRIZZLED FILBERT (*Frizzled nut, Cape nut*).—Husk hairy, twice as long as the nut; deeply frizzled and spreading open at the mouth; nut small, oblong, and flattened; shell thick; kernel full. This is a rather late variety. The tree is an excellent bearer. The nuts are produced in clusters.

LAMBERT FILBERT (*Kentish Cob, Filbert Cob*).—Husk nearly smooth, longer than the nut, and very slightly cut around the margin; nut large, oblong, and somewhat compressed; shell rather thick, of a brown color; kernel full and very rich flavor. This is, perhaps, the best of all filberts. The tree is a most abundant bearer. Some of the nuts are upward of an inch in length, and they have, with care, been kept for four years. It is only after being kept for some time that their full richness of flavor is obtained. Mr. Hogg says this nut was first brought to the notice of the Horticultural Society by A. B. Lambert about the year 1812. It is improperly called Kentish Cob. The true Cobs are roundish, thick-shelled nuts.

PEARSON PROLIFIC (*Dwarf Prolific, Nottingham Prolific*).—Husk hairy, shorter than the nut; nut medium in size, smaller than the Cob, obtusely ovate; shell rather thick; kernel full. A very excellent variety. Trees are most abundant bearers, sometimes laden with fruit when not more than 2½ feet high.

PURPLE FILBERT (*Purple leaved*).—This differs from the red filbert in having the leaves of a dark, blood-red color like those of the purple beech. The fruit is similar to and quite as good as that of the Red Filbert, and is of a deep purple color.

RED FILBERT (*Red Hazel*).—Husk hairy, longer than the nut; nut of medium size, ovate; shell thick; kernel full, covered with a red skin.

WHITE FILBERT (*Wrotham Park*).—Husk hairy, longer than the nut, around the apex of which it is contracted; nut medium sized, ovate; shell thick; kernel full, covered with a white skin.

AMERICAN HAZELS (*Corylus Americana* L.; *Corylus rostrata* Michx.; *Corylus Californica* Rose.).

The first two species, though widely distributed and showing considerable variation in size and quality of fruit, seem never to have attracted the favorable attention of our cultivators. They form a persistent, shrubby growth in pastures and fields in many sections, and because of their suckering habit often become a nuisance to farmers and stockmen. It is interesting to note that many superior types have been noticed, and both species seem worthy of more attention than they have received. These species are often together, and in general their area of distribution coincides, though *C. rostrata* extends farther north and west in the New England States and Mississippi Valley, and it is also found on the Pacific Slope in California, Oregon, and Washington, where it attains a larger growth than elsewhere. The most marked distinction between them is in the form of the involucre surrounding the nuts. In *C. Americana* this is composed of two broad, short bracts, which at maturity open so as to disclose the nuts. (Pl. 13, figs. 8, 9.) The involucre of *C. rostrata* is tubular, closely surrounding the nut and prolonged beyond it into a bristly beak. (Pl. 13, fig. 17.) The quality of the nuts of *C. rostrata* is inferior to that of *C. Americana*.

Of *Corylus Californica* Rose,¹ we have received interesting specimens from both Washington and Oregon. It is found in the lower mountains and foothills from middle California, through Oregon and Washington, to British Columbia. The nuts are single

¹ Garden and Forest, Vol. VIII, page 263.

in the involucre, as are all the hazels, but by a singular morphological change in some of the bracts composing the involucre of some specimens, what appears to be a single involucre contains two nuts. (See illustration, pl. 13, figs. 18, 18*a*, 18*b*, 18*c*, 18*d*.) In normal involucre the tubular form common to *C. rostrata* is observed, though the tips are often shredded down to the base of the nuts. The nut is more elongated than the types of either *C. Americana* or *C. rostrata*, much resembling the acorn of the white oak (*Quercus alba*), in form, and is of medium size, with a thick, hard shell and a shield much depressed at its margin. The skin of the kernel is thick and brown; the kernel plump, sweet, and of good quality; the umbilical suture direct.

NOTES FROM CORRESPONDENTS.

So many superior hazels are noted by our correspondents that it is thought best to briefly mention some of the most promising ones for the information of those who may desire to undertake the improvement of this nut.

Arkansas.—Samuel H. Davidson, Evening Shade: "An oblong nut nearly as large as the filbert."

California.—Report of State Board of Horticulture, 1891, page 87: "Native to northern portion of the State, and can be found from valley land to the mountains' tops. Very productive and hardy, bush from 3 to 8 feet high. Nuts generally in pairs, sometimes three or four in a cluster. It is found along the coast from Mendocino to Oregon."

Illinois.—W. E. Patterson, Gila: "Have noticed a choice wild variety; bush stocky; husk large; nut flat; even, rich brown color; shape nearly round."

Indiana.—George M. Rumler, Mohawk: "Have noticed a very large, flat nut."

A. C. Harvey, Lafayette: "Have noticed a choice wild nut; large, early, prominent in the husk."

E. J. Chancellor, Bicknell: "Some are very fine, the finest are large and rather flat."

F. H. Linton, Tillman: "Have noticed wild varieties; the stock grows 8 to 12 feet high with one to four nuts in a cluster. Very large."

Henry Fatick, Middletown: "Have noticed large nuts in large clusters."

Iowa.—E. L. Kirk, Pulaski: "Have noticed very large wild nuts; almost as fine as filberts."

Kentucky.—J. C. Alexander, Bowling Green: "Have noticed wild nuts; they are large."

Michigan.—Allan Crawford, Springport: "Have noticed wild varieties, choice both in size of nuts and thickness of meat."

Minnesota.—C. F. Brown, St. Peter: "A few under cultivation show large nuts."

Missouri.—F. C. Meyer, Greenfield: "Have noticed choice wild varieties, large, flat, and long; thin shelled."

Robert A. Turner, Long Oak: "The Turner is very large and beautiful."

Peter Daling, Baring: "Some as large as filberts."

New York.—R. C. Hall, Canajoharie: "I transplanted one several years ago; it has borne fruit every year. It does well and is very thrifty." (Pl. 13, figs. 10–13.)

E. W. Dutton, Livingstonville: "About the size of the large ones in market; found on bushes from 6 to 10 feet high; growing on light, warm, dry soil, in Schoharie County."

Ohio.—George C. Betts, Bailey: "Of large size and thin shell." (Pl. 13, fig. 9.)

C. W. Faust, Canton: "Resembles filberts."

George J. Streator, Garrettsville: "A few show superior qualities."

John S. Clark, Mechanicstown: "Some very nice and large."

Oregon.—O. P. S. Plummer, Portland: "Bushes large and tall; nuts good size, generally grown single, some are in pairs."

David Smith, Meadow: "Different from the hazelnut; people here call them filberts. These bushes grow as much as 30 feet long, and are found as much as 6 inches through at the butt. They are tough, and are used for withes. We twist them like eastern hickory—while hazel is very brittle. The nuts are found usually one in a place, sometimes two; the nuts never grow in bunches or clusters as hazel nuts." [Probably *Corylus Californica*.]

Tennessee.—John C. Chilton, Otto: "Have noticed a choice wild variety, very large and of fine flavor." (Pl. 13, figs. 14–16.)

Wisconsin.—George P. Pepper, Pewaukee: "Long Shocks (a local name), an oblong, very thin-shelled nut."

Washington.—T. J. May, Mount Vernon: "Hazelnuts flourish here as in no other country that I ever saw; they are native and grow all through the timber. They grow on trees instead of bushes; many of them growing to the height of 50 or 60 feet and to the diameter of 4 or 5 inches. They grow so tall and slender that they bend over and others sprout up and bend over, and still others until there is a great cluster, all bending outward. They bear well when they get enough sunlight, and it is evident that they do not require a great deal." In June, 1891, Mr. May sent young, growing wood, foliage and nuts, also mature wood growth, and says: "Since writing you before, I have seen a tree that measures 6½ inches in diameter. It bears fruit in clusters; the size of fruit about the same as that of Eastern States and quality as good."

THE CHESTNUTS.

(*Castanea Tourn.*)

The name *Castanea* is believed to have been derived from *Kastanea*, a city in Pontus, Asia Minor, where the chestnut is native, or from a city of the same name in Thessaly, where it seems to have been first introduced into Europe.¹ This tree, the so-called European chestnut, has by some been considered indigenous to Great Britain and the continent of Europe, but the evidence all points to its introduction into Greece from Asia Minor, thence to Italy by the Romans, and to its gradual dissemination throughout southern and western Europe. It has for centuries grown wild in Italy, France, Spain, and Great Britain. Botanists have long disputed whether the chestnuts of America and Japan are varieties of the European species or are themselves worthy of specific rank. From a pomological standpoint the differences are so marked that we shall in our discussion regard them as three distinct species.

The male flowers of the chestnut are produced in the axils of successive or alternate leaves, in early June, in cylindrical catkins as long or longer than the leaves. They appear after the leaves are nearly grown, later than the bloom of most other trees. The pollen is usually abundant and fragrant, in some cases so much so as to cause hay fever in persons subject to that disease. The female flowers are borne in four-pointed burs on stiff spikes that grow from the axils of the leaves on the extended shoot. They are thus developed later and on younger wood than the male blossoms. At the time of blooming the burs are about half an inch long, and in most cases but from one to three flowers near the base of the spike produce fruits. The lower portion of the stock becomes woody, and a portion beyond them shrinks and drops off, leaving the burs as a terminal cluster. Rarely trees of the American chestnut have the habit of maturing the fruit from all, or nearly all, the female flowers along the entire spike.²

¹ See London, *Arboretum et Fruticetum Britannicum*, Vol. 11, page 1983.

² In the Division of Forestry of the Department of Agriculture there is preserved a record and specimens of fruit from a tree in Pennsylvania which has this habit.

AMERICAN CHESTNUT (*Castanea dentata* Marsh.).(Synonym: *Castanea sativa* Miller, var. *americana* Sarg.)

As previously noted there is a diversity of opinion among botanists concerning the rank which this tree should occupy—whether or not it should be regarded as a distinct species. Most American botanists have followed DeCandolle in holding it to be a variety of the European chestnut, and as such it will be found in Gray's Manual (6th edition, 1889); *Castanea sativa* Miller, var. *americana*. There seems to be good reason, however, for regarding it as a distinct species and accepting Mr. G. B. Sudworth's determination of the earliest name identifiable with it,¹ we have thus regarded it. It is a large tree, with oblong, lanceolate, pointed leaves, acute at the base, with coarsely dentate margin, smooth and green on both sides when mature. The nuts are very sweet, and are rarely single, commonly two to seven in an involucre, and in the latter case are flattened on one or both sides. In some cases the involucres are spiked. The most striking differences between this and the foreign chestnuts are its taller, more slender and upright growth, thinner and smoother leaves, which are more pendent in their position than those of the European and Japanese trees, and its uniformly smaller and sweeter nuts.

GEOGRAPHICAL DISTRIBUTION.

Within North America the chestnut is found native from Portland, Me., through southern Vermont, along the south shore of Lake Ontario, across the Province of Ontario, Canada, the southern extremity of Lake Huron, thence southward across the southeastern corner of Michigan, across southeastern Indiana and Illinois, almost to the Mississippi; thence southward through Kentucky, Tennessee, and Mississippi to Louisiana, and in a southeasterly direction across Mississippi, Alabama, Georgia, and North Carolina to the coast. Within this area it occurs either singly or in mixed forest growth, usually on high, sandy land, gravel ridges or mountain slopes either wholly or comparatively free from limestone. Replies received from 150 correspondents in answer to the question, "What conditions and soil are most favorable to chestnut culture?" indicate that four-fifths of the observers favored high land for the chestnut as compared with low land; that nearly two-thirds of these prefer dry, rocky, sandy, gravelly soil to those of a richer and more compact character, and that there are a few cases, at least, where chestnut trees make a fine growth on limestone land, notwithstanding the popular belief to the contrary.

The possibility of extending the area of growth of the chestnut has received some attention, but not much that is definite and conclusive has been determined. The most promising fields for this extension seem to be along the northern boundary of its native growth, on gravelly or sandy hillsides and mountain slopes where a healthy growth of tree can be secured, and where the wood will ripen early enough in the autumn to avoid danger from severe winters. On deep prairie soils and alluvial bottom lands the chestnut is reported as short-lived and unsatisfactory in growth. B. F. Johnson, of Champaign, Ill., believes this is because of the presence of lime in such soil, as he finds that the chestnut does well on gravelly or sandy ridges even in prairie regions. Under cultivation the chestnut has made a satisfactory growth as far north as Saco, Me., and in warm clay locations in Vermont the tree fruits well. In the latter State the chestnut has grown, in a small way, for seventy-five years. In Michigan there are numerous small plantings now yielding nuts, the most extensive work in this line having been by the Lake Shore and Michigan Southern Railroad Company, along this line of road. In Wisconsin planted chestnut trees have made a satisfactory wood growth at Pewaukee and West Salem, but the nut crops have been irregular and light. At Weyuawega ten chestnut trees, planted in 1858 and

¹ Bul. Torrey Botanical Club, May, 1892.

transplanted in 1859, are reported to be in excellent condition. John P. Roe attributes their success to their being grown from northern seed. Alvin S. Bennett,¹ the grower, said, in 1884: "The seed was grown at Groton, Mass. The trees are growing on a northern slope, in sandy soil with gravelly subsoil." Attempts to grow the chestnut in the prairie States have, in the main, been unsuccessful. A majority of the reports from Illinois express great dissatisfaction at the results of efforts to grow the nut there, and from Iowa, Kansas, Nebraska, and Texas come similar reports, except where the trees have been protected. There are a few trees in most of the prairie States that occasionally produce nuts, but in general they are with difficulty maintained in good condition, owing to the disastrous effects of dry winds and cold winters. A simple and effective protective device for use in those States is noticed under the discussion of the Persian walnut (p. 30). In Florida the chestnut does poorly on its own roots, but grafted on chinkapin, it is reported to make a satisfactory growth on the thin sandy soil of that State. California reports more failures than successes. A grove of 250 trees at Sonoma, now about 15 years old, has been bearing a few nuts during the past five years. At Nevada City and at Winters the American chestnut is fruiting.

DECLINE OF VIGOR IN THE CHESTNUT.

From causes not well understood there is a marked decline in the vigor of the chestnut throughout the broad area of territory in the Southern States, where the white man found this tree among the most thrifty of the original forests. Down to the first quarter of the present century there seems to have been no mention of the trouble in the chestnuts of that section. Within the memory of residents of the Gulf States the chestnut flourished in all their higher lands. In point of time, the trouble seems to have begun on the most southern limit of chestnut growth, and there the destruction has been most complete. It has pushed its encroachments throughout Mississippi, Alabama, Georgia, and South Carolina, and is now reported in the strongholds of chestnut growth in North Carolina, Tennessee, and Virginia. Observation of the native chestnut growth in Maryland and Virginia discloses the fact that many trees are dying without apparent cause. In some sections this is attributed to the ravages of insects; in others to an unknown disease resembling blight. There is need for a more thorough investigation of this subject than has yet been made. No injury to the Japanese or European chestnuts planted in this country is yet reported.

PRODUCTIVENESS.

There is a wide difference in the fruitfulness of wild trees—some bearing but a few nuts annually, others yielding regular crops of one or more bushels to the tree. This difference will need to be taken into account when selecting trees from which to propagate, for there is no reason to doubt that the bearing habit, whether it be generous or scant, will follow the tree into cultivation. Though generally unisexual, chestnut trees standing alone so frequently fail to produce nuts that the opinion has been frequently expressed by various observers that the chestnut is sometimes dioecious; thus Fisher Ames, Lakeside, Mich., reports: "I have one seedling which has stood alone for forty years and given but five perfect burs. It blossoms every year."

Joshua Shaw, Ilion, N. Y., says: "I know a few trees in the country that bear very fine nuts if two or more trees stand near each other. A lone tree will have burs, but false nuts."

Such cases do not necessarily prove that the solitary trees were pistillate, producing no staminate blossoms; and in the absence of any authentic record of mature trees found by actual examination at blooming time to be dioecious, it is more than likely that the barrenness of solitary chestnut trees will be found to arise from a

¹ Wisconsin Horticultural Society, Report 1884, page 111.

lack of simultaneous blooming of the staminate and pistillate blossoms, or to an inability of some trees to produce fruit except by cross fertilization.

The largest yields reported are from scattered trees in pastures or open fields not far removed from other chestnut trees. Trees producing large quantities of nuts are usually found to have several nuts in a bur, sometimes as many as five to seven, while less productive trees yield but two or three and sometimes only one nut to the bur. These traits are found to be reasonably constant, and are worthy of attention when selecting trees from which to propagate.

There is a general impression that the larger nuts of the American species are not abundant croppers; but it will be seen under the heading of "Choice wild nuts" that there are wild nuts large in size, of excellent flavor, that are heavy bearers, and that of these some are persistent annual bearers.

GENERAL INTEREST IN CHESTNUT CULTURE.

The number of trees in cultivation is increasing every year. Replies to our inquiries were not full enough to form any basis of enumeration of the trees already planted, but they afford evidence of a growing interest in orchard culture of this tree. California reports orchards of 200 to 300 trees, generally the Japanese and European varieties. Orchards of from 100 to 300 trees are also reported in Delaware, southern Illinois, Indiana, Michigan, Pennsylvania, Tennessee, and Virginia. Charles Parry, of Parry, N. J., has 1,000 grafted trees. Of small plantings, ranging from 1 to 25 trees, there are numerous reports from all sections.

H. M. Engle, Marietta, Pa., says: "Talk about nut culture when they grow wild and take care of themselves! So did apples, pears, peaches, cherries, and all other fruits at some period in the past, and it was only by selection of the fittest that we now have so many varieties of such excellent fruits. What has been done in this line with fruits may be accomplished with nuts. The great progress in chestnut culture will be by a different method, viz: The hillsides and mountain slopes of chestnut timber will be cut and a proper proportion of the sprouts grafted with choice varieties, and all the rest of the sprouts and underbrush destroyed. By such method, chestnut groves will be established without planting, and by their rapid growth will make bearing trees in a comparatively short time. This plan is not altogether speculative since four to five years of practical work of this kind justifies me in making such statements and, if I am not mistaken, the boom in chestnut culture will be by such methods."

Prof. William A. Buckhout says:¹ "In the diversification of industries which is now deservedly attracting so much thought and attention, the increase of our plants for cultivation should find a place, and of cultivated plants the nut-producing trees are among the most promising. Nuts have a higher nutritive value generally than have those fruits which are made up of the fleshy coverings of the seed, as in the apple, peach, etc. They are rather of the nature of staple articles of diet, and approach the grains in food value. They are, moreover, not of the perishable class, and are easily handled with little waste and risk. While all the nut trees are probably capable of improvement, and each has adaptation to its particular situation, the one most promising for Pennsylvania is the chestnut." To some extent it can and has been grown in places where it is not native, and in soils not of light and gravelly nature, but generally imperfectly and with difficulty, and the trees have been sterile, or at least irregular and uncertain in fruitage. It has been noticed that near the borders of the area in which this tree is native it is quite liable to be barren and to attain a meager size and development. The larger size, dwarf habit, and early fruitfulness of the Japanese chestnuts give them special value, and if they can be worked upon stocks of the American species we can secure trees that will

¹ Bulletin No. 16 of the Pennsylvania Agricultural Experiment Station.

bear earlier and produce larger nuts than our native species. It would seem possible by hybridizing to combine the hardiness, vigor, and quality of the American species with the larger size of fruit and precocious bearing of the foreign sorts.

PROPAGATION.

If the seed has been properly cared for, the growing of seedling chestnut trees is comparatively easy. Concerning the best method of keeping seed through the winter, little need be said except the general directions given for all nuts on p. 11. The only special attention required after sprouting is to separate the sprouts in nuts having more than a single germ, as is frequently the case with the European and Japanese nuts, and occasionally with the American.

PRESERVING CHESTNUTS FOR SEED.

Samuel C. Moon stated before the Nurserymen's Association that his method of keeping nuts for seed had given him only moderate satisfaction. By it the nuts are gathered as fast as they fall, and are spread out upon the floor about two days until they go through the process of sweating, and the moisture is dried off. They are then stratified in sand, placed in a cool cellar, and kept until spring. Sometimes as many as 90 per cent of the nuts will sprout in the spring; in other instances they will nearly all be moldy. The reason for not planting in the fall was to prevent the destruction of the nuts by vermin, squirrels, or mice.

W. G. Storrs says his firm bought the nuts in the fall from growers, put them in boxes, three parts sand and one part chestnuts. These boxes were buried about 1 foot deep under the soil; they had always been successful in keeping them in growing condition.

BUDDING AND GRAFTING.

Neither budding nor grafting is very successful with the chestnut in the dry climate of California, though some propagators report satisfactory results with the cleft graft, especially on Japanese seedlings. Shield budding is said by the State board of horticulture to be best performed in August. A freshly cut bud is immediately inserted in an incision in the stock and is tied tightly with cotton twine. In three weeks the strings may be removed. The buds are left dormant until spring. The tops of the stocks are cut back in March to force the buds to start.

From the New England States come very few reports of efforts to bud or graft the chestnut. In Massachusetts the Japanese varieties have been whip grafted on American stocks with fair success in Middlesex County.

In Delaware both cleft graft and whip graft have given quite satisfactory results. In Florida both budding and grafting are practiced. By grafting, whether cleft graft or whip graft, nearly all grew; by budding some propagators have not had satisfactory results. Worked into the chinkapin as stocks, either the European or Japanese chestnuts come into fruit in one or two years. For budding on the chinkapin the buds are cut the same as for the orange; the wood is left in the bark and the parts are well tied. In Georgia both budding and grafting have given satisfactory results. Seedlings of European chestnuts are among the stocks used; the seedlings are transplanted for one year and then whip grafted without taking up the stocks. Where the cleft graft is used the operation is performed early in the season; the bottom of the graft is made quite thick and the wax is applied heavily and thoroughly. The budding is done by the ordinary shield method, making a cross-shaped incision on the stock, slipping the upper part of the bark of the bud into the upper part of the incision, and using special care in the operation.

In Illinois root grafts, with pieces of chestnut roots for stock have grown reasonably well. By side or bud grafting in the spring, when the bark lifts easily, satisfactory results are obtained. In Indiana side grafting (sometimes called veneer grafting) has been the best method tried. After the operation no branches or side shoots are

allowed to grow on the stock. In Kansas dormant buds, set as early in the spring as the bark will peel, have given satisfactory results. The wood was removed from the bud. In Maryland fair success is reported with budding the same as for other fruits, except that the wood is left in the bud; satisfactory results are also obtained with whip grafts while the trees are small. In Michigan root grafting has been attended with some success. Satisfactory results have been obtained by the usual methods of cleft, saddle, and splice grafting when the work was done early in the season. In New Jersey some seasons give much better results than others. Some growers report their custom to be cleft graft in April with not more than one-twentieth failures. Others whip graft small trees, of 1 inch or less, and wrap with waxed muslin; on larger trees, from 2 to 12 inches, they slip graft and cover well with wax. J. T. Lovett says American stock is better than Spanish or European for grafting the Japanese nuts. He does not know that it is the best, but it is the best he has used. Two or 3 feet above the ground has given best success. Low-set grafts are liable to be broken out in working the first season. He has worked both whip and crown method, and the former has been more successful. Unless the graft and stock are both cut very true and smooth, so that the former will fit the latter closely the entire length of the cut, the union will not be perfect and a large excrescence of unnatural growth will form at the junction; this will increase from year to year until the graft is broken out.

In New York both budding and grafting of Japanese chestnut on native stocks have been successful in Rockland County. Whip grafting early in March has been successful in Washington County. In Yates County both whip and cleft grafting have been attended with good success, but generally growers bud here in the nursery rows. In Ohio both budding and grafting are quite successful. One method of successful budding here is to cut a bud with a square plate of bark, take it off carefully, say, three-fourths to 1 inch square, place it on the tree, and cut out a plate of bark so the bud will exactly fit. Then remove the bark from the stock and carefully place the bud in and tie firmly. In Pennsylvania budding is reported as unsatisfactory, but grafting has been fairly successful. H. M. Engle's method has generally been cleft grafting; he finds little if any difference whether the scions are cut in the fall or in the spring. He has been quite successful with scions cut in grafting season, and put in at once, even so late that the buds have swollen. The grafting wax is made about the consistency of taffy, in which condition it can be kept for years in a cool place. The best success is reported with trees 3 to 4 feet high, top grafted. In Chester County, J. Hibbard Bartram finds it hard to get chestnut grafts to take. He has cleft grafted some, but mostly whip graft. He had a few to grow in a clearing by placing the scions down between the bark and wood. Has succeeded best by grafting late. In Montgomery County budding was successful with John D. Souder, while grafting was not. In Bucks County, H. W. Comfort has grafted trees 5 feet high or taller, sawing off square and splitting, then using two scions. He has been moderately successful. Samuel C. Moon's method of grafting is to cut the scions early and keep them dormant in an ice house until the stocks start and their buds are well swollen, usually about the middle of April. Then cut off the tops and insert tongue grafts and wrap with waxed muslin. It is important that the stock and scion be nearly the same diameter, otherwise the union will be imperfect. There is not much difficulty in grafting well-established, thrifty trees of any size, providing branches can be found of proper size to fit the grafts. Mr. Moon says: "I have tried grafting one-year seedlings at the collar as they stood in the nursery row; also by taking them up and grafting on whole roots as apples are done, but without success. I have also failed with budding in the ordinary way."

F. W. Burbidge¹ affirms that the chestnut succeeds well grafted on young seedlings of black oak, while Baltet² says: "The chestnut succeeds when grafted on

¹ Cultivated Plants, page 271.

² Art of Grafting and Budding, page 176.

young oak plants which have been sown where they are to remain permanently or which have been freshly transplanted. They should be grafted by ordinary cleft grafting or in the forkings of the branches. When the sap commences to flow they may be branch grafted on the sides under the bark. The scion in this case is a small branch, or part of a branch, from 4 to 8 inches long, having the lower part cut with a long, splice cut, the surface of which should be perfectly smooth and cut thin to the bark at the point. This shoot when developed will form a branch almost perpendicular to the stem. The scion having been prepared, we make on the stock two incisions forming a T through the bark, the bark is raised and the scion slipped under it, so that the top of the spliced cut may be on a level with the transverse incision in the stock. It is then bandaged, and the air excluded from the cuttings by the application of clay or wax. It is preferable to graft close to the ground."

CULTURAL DIRECTIONS.

In the orchard spaces should be left between the trees of from 40 to 50 feet, unless varieties are of dwarfish growth. The use of the spaces between for growing other crops till the chestnut shades the ground is neither more nor less objectionable than the cropping of orchards of other fruit trees. If the land is annually well fertilized for the crops to be grown and the culture is thorough, the trees should make satisfactory growth.

AGE OF BEARING.

Samuel C. Moon says an orchard of Numbo or Paragon chestnuts will become profitable as early as an orchard of Baldwin or Smith Cider apple, and pay as well. He continues: "The bearing age for chestnuts is similar to that of apples and pears. Natural trees usually commence to bear from 12 to 20 years of age and grafted trees of the most prolific varieties in from two to seven years after grafting, varying, of course, with the age of the stocks on which they are grafted, and other conditions."

PREPARATION FOR MARKET.

The nuts may be best prepared for market by plunging into scalding water as soon as gathered. It can be done by placing a bushel of nuts in an ordinary washtub and pouring boiling-hot water over them in sufficient quantity to cover the nuts. Stir the nuts in the water to equalize the heat. The wormy nuts will float and are easily removed. The eggs and larvæ of all insects are destroyed by this process and the meat of the nuts cures without becoming flinty hard in the curing for winter as in ordinary drying of the nuts. The water should be drained off after remaining about fifteen minutes, and the nuts should be carefully dried. For drying they may be placed in sacks in such quantity as will allow their loose spreading about 2 inches thick; the sacks should be frequently turned and shaken up as they lie spread in the sun or dryhouse. When surplus moisture is driven off and the risk of molding is avoided, the nuts may be packed in barrels or otherwise stored for the winter. It will be found that such nuts are quite tender, retaining for a long time much of the quality that makes them so acceptable when fresh. Nuts that have been scalded will not germinate. Prices at which chestnuts sell per bushel range in different reports as follows:

	Per bushel.		Per bushel.
Alabama	\$3.00 to \$4.00	Massachusetts	\$2.00 to \$5.00
Connecticut	1.00 to 4.00	Michigan	3.00 to 5.00
Canada	4.00	Nebraska	5.00
Georgia	.50 to 5.00	New Jersey	2.00 to 6.00
Illinois	6.00	New York	2.00 to 10.00
Indiana	3.00 to 5.00	Ohio	2.50 to 10.00
Kentucky	1.00 to 2.00	Pennsylvania	7.00
Maryland	1.00 to 3.00		

INJURIOUS INSECTS.

There are many species of *curculio* that infest the chestnut; in portions of Tennessee these are so numerous as to ruin almost the entire crop of nuts. Also in large areas of Delaware, Maryland, and Virginia these insects ruin the bulk of the crop of chinkapins and greatly injure the chestnut. The only remedial check thus far found is the scalding described above.

CHOICE VARIETIES.

Special effort has been made to secure from each correspondent specimens of the best nuts known to him. In each case the sender was requested to mark the tree from which specimens were sent, that there might exist no doubt of identification for purpose of propagation. We are satisfied that the search so made was by no means an exhaustive one, though as thorough as could be made under attending circumstances. To encourage more careful notice of the wild nuts, and to secure efforts at propagation of the best, we give somewhat extended space to the report of the more promising chestnuts recorded at this office.

NOTES FROM CORRESPONDENTS.

Thomas Brigden, South Lowell, Ala.: "Found two trees with much larger nuts and at least two weeks earlier than usual."

Benjamin R. Townsend, Wallingford, Conn.: "I have seen some very large chestnuts, two-thirds to three-fourths of the size of those imported."

George W. Endicott, Villa Ridge, Ill.: "Some of mine are from the wild chestnut, and are very fine and large."

John B. Lewis, Eubanks, Ky.: "I have one tree which bears nuts nearly as large again as ordinary ones."

James S. Harris, Still Pond, Md.: "I have some abundant bearers and some that bear smaller crops of large nuts."

B. Hathaway, Little Prairie Ronde, Mich.: "Among my 100 bearing trees I find many bearing much larger nuts than those of the wild type. One of these I have grafted, and have perhaps 20 trees of this sort 2 or 3 years old."

Daniel W. Babcock, Dansville, N. Y.: "I have one tree about 20 years old, very productive, with very large nuts. I have some seedlings from this, but not in bearing."

J. R. Hawkins, Mountainville, N. Y.: "I have some specially early; others large in size and some of peculiar shape. The finer sorts bear more sparingly. Some early ones are very prolific. Those in the forest bear only on top, in very limited quantity."

E. L. Roser, Brittain, Ohio: "On one of my trees the nuts are a great deal larger than on any other; I have noticed it for ten years."

Samuel Rau, Columbiana, Ohio: "There are some very choice nuts on adjoining lands—large to very large."

William Pryor, Cuyahoga Falls, Ohio: "I have some very large and delicious ones in flavor; others very early in ripening."

George J. Streator, Garrettsville, Ohio: "I have a few fine varieties well worthy of cultivation."

William King, Newton Falls, Ohio: "Some of mine have larger nuts than others and many more in the bur."

George T. Ralston, Freeport, Pa.: "I have one large, sweet nut; it is as large as any of the cultivated ones."

George W. Oster, Osterburg, Pa.: "There are two trees in this vicinity that bear more than ordinarily fine nuts; large and sweet."

F. L. Hartford, Sterling, Pa.: "I have one tree, the nuts of which are three times as large and of better flavor than others near it."

George E. Murrell, Coleman's Falls, Va.: "I have some trees that bear the finest native nuts I ever saw. Near Parr, Va., is a tree bearing two complete nuts in each shell."

James E. Kendall, Gazil, W. Va.: "I have some much earlier, and some larger, others drier and sweeter than the ordinary kinds. By cutting out other forest trees and old chestnuts I have a natural grove of 150 trees in full bearing, and they are bending under their load of nuts. I find early, medium, and late nuts in same grove and same exposure to the sun. Some of the earliest are now ripe and beginning to fall out—September 24, 1890."

T. S. Chapman, Holidays Cove, W. Va.: "I have one very early variety which ripens one week before any others and is twice as large as the ordinary nut."

NAMED VARIETIES.

BROADBENT.—A good-flavored nut of medium size. The tree is growing upon the farm of B. Broadbent, at Fay, Pa., where it is said to be a great bearer.

CLARK.—An early nut of medium size, and very generally sound. Tree large and productive; on the farm of R. B. Clark, Fay, Pa.

COOPER.—Reported by H. W. Comfort, Fallsington, Pa.: A variety grown largely in the vicinity of Philadelphia. Nut large, borne in a very large bur, which in time of much rain is liable to break the trees badly. Tree is a vigorous grower and very productive.

DULANEY (pl. 14, fig. 9).—William L. Dulaney. Above average in size and quality. From a productive tree growing by itself near Bowling Green, Ky.

EXCELSIOR (pl. 14, fig. 4).—James E. Kendall, Gazil, W. Va. A quite large, downy nut, irregular in form and size, often seven nuts to the bur; quality good. Tree growing thriftily in sandy loam.

GOVERNOR WOOD.—Reported by Edwin Allen, New Brunswick, N. J. Mr. Allen has been growing for fifteen years two budded trees received from Wisconsin. They have borne only a few nuts produced singly in the bur. The nut is long, cone shaped, quite large, and good.

GRIFFIN (pl. 14, fig. 10).—J. N. Harris, Griffin, Ga.: A large, very downy nut, of good quality.

HATHAWAY.—A large, light-colored, sweet nut, propagated by B. Hathaway, of Little Prairie Ronde, Mich. The original tree is now about 8 inches in diameter of trunk, and is a full, annual cropper. Mr. Hathaway writes: "Many burs have fine nuts; not infrequently seven nuts are found in one bur, and I have found one bur with eleven fully developed nuts in it."

HULSE (pl. 14, fig. 3).—From Wells Hulse, Campbell Hall, N. Y. A quite irregular nut, above medium in size, of good flavor.

KETCHAM (pl. 14, fig. 5).—Sent by J. R. Hawkins, Mountainville, N. Y. Nut above medium in size, somewhat elongated, downy, sweet, and of good quality; ripens middle of September at Mountainville, in Orange County, N. Y. Tree 50 years old, growing vigorously in moist clay loam, in meadow land of heavy sod.

LAWVER.—A nut introduced by A. M. Lawver, of South Pass, Ill., about twenty-five years ago. Valuable for its fruit.

LIGO.—Nut of medium size, sweet and good; borne on an old tree which is very productive. Sent by R. B. Clark, Fay, Pa.

MILLER.—Reported by Charles Parry, of Parry, N. J.

MURRELL (pl. 14, fig. 2).—George E. Murrell, Coleman's Falls, Va. Nut very large, borne three nuts in the bur; quality good.

OTTO (pl. 14, fig. 8).—J. C. Chilton, Otto, Tenn. A quite large nut, long in form. The highest flavored chestnut received.

WATSON (pl. 14, fig. 7).—R. B. Clark, Fay, Pa. Quite large, flattened, slightly ribbed; quality good.

WILLIE.—J. R. Hawkins, Mountainville, N. Y. Size small, quality good; ripens middle of September. Borne on a very large tree that produces a heavy crop annually.

FOREIGN CHESTNUTS (*Castanea sativa* Miller; *Castanea Japonica* Blume).

The European and Japanese chestnuts are by many considered identical, and there are certainly fewer differences between them than between either one and the American chestnut. There are discernible differences in the size and form of the trees and in the general appearance and quality of the nuts, however, and we have retained the specific name for the Japanese nut, as noted above. Neither of them yields nuts of as good quality as the American, though both excel our nut in size. Considerable quantities of the European nuts are imported from Italy and Spain for sale in our cities, where they are commonly roasted and sold from retail stands. In California cities the Japanese nuts find a somewhat limited demand. Both species can be grown in portions of this country, either as seedlings or as grafted trees on American stock, and there is every indication that varieties combining the desirable qualities of our native nuts with the precocious bearing habit and large size of the foreign nuts will soon be produced. Of both European and Japanese chestnuts, Samuel C. Moon says he has never eaten one that equaled in sweet, delicate flavor the small native varieties. In most large nuts there is more or less astringency in the skin that covers the kernel, but boiling or roasting corrects this defect, and after they are cooked and the skin removed there is but little difference in the taste of different varieties. The majority of imported trees and seedlings raised in this country from imported nuts are injured or killed entirely by our severe winters. It is doubtful if more than 5 per cent of the imported European chestnuts live long enough to come into bearing, but stocks raised from seed of the few exceptional hardy trees which do flourish here are generally hardy, and in this way a strain of European chestnuts has been secured that is well adapted to the climate of the Eastern States. In habit of growth the European chestnut differs from the native species about as the Norway maple differs from the sugar maple. The foreign species branches low and forms a round-headed tree, while the American grows taller and more spreading. Another characteristic distinction is in the nuts, the fuzz about the point being thicker and covering a much larger proportion of the shell on the American than on the foreign species.

EUROPEAN CHESTNUT (*Castanea sativa* Miller).

The European chestnut as grown in this country is a moderately strong growing tree with a rather low, flat top. Its leaves are thicker and more leathery in texture and are commonly smaller than those of the American. Many specimens are cordate at the base, though this character is far from constant; the dentation of the margins is less marked and the young leaves are conspicuously pubescent. The nuts of the European species are larger, of a brighter brown color, distinctly ribbed in many instances, and uniformly poorer in quality than the American. Trees from nuts imported from France and Spain have been fruiting for at least a half century near Philadelphia, Pa., and Wilmington, Del. One in Montgomery County, Pa., is reported by H. W. Comfort,¹ as over 50 years old and bearing when full 3 bushels of nuts. The tree is 40 feet high and has a spread of 50 feet. From nuts borne by these scattered trees several seedlings of much promise have been grown, one of which at least, the Paragon, shows some indications of partial American parentage. They are superior to the imported trees in hardiness, and the nuts of some of them

¹ Report Pennsylvania Horticultural Association 1891, page 20.

are of better quality than the imported nuts. Careful selection from the best types, and systematic crosses with the American nut will doubtless yield varieties superior in quality to any of those we now have. To aid in the supply of material for this work as well as to determine in some degree the comparative hardness of the European chestnut, the Department of Agriculture in January, 1892, distributed in small lots to 150 nut growers and agricultural experiment stations a bushel of choice Italian chestnuts grown on the slopes of Mount Ætna. They were received by the courtesy of the State Department through the personal effort of Mr. Charles Heath, our consul at Catania; they were nuts of fair size and of better quality than most of the European chestnuts.

NAMED VARIETIES.

BARTRAM LATE.—Reported by William Parry, of New Jersey, as a valuable variety, ripening about the middle of October. The nut is medium in size, bright in color, and uniformly three in a bur. Their bright color and freedom from worms insure ready sale at good prices.

COMFORT.—Reported by Mr. Parry as a very productive variety. Nuts above medium in size, borne two to three in the bur, ripening in midseason; of excellent quality. The tree comes into bearing when very young.

DAGER.—Specimens from J. W. Killen, Felton, Del. A seedling of the Ridgely; larger and perhaps better in quality than the parent. The original tree is about 40 years old, growing near Wyoming, Del. It is being propagated by grafting.

EUREKA.—This nut is of Spanish type; quality above the average; tree rapid grower, with spreading habit; productive. Has been grown in Christian County, Ky., but the tree is injured by sudden and severe changes of weather in winter and spring in that locality.

HANNUM.—Ripens at Parry, N. J., October 1–10. A very heavy, annual cropper; nuts large, of brightest color; the number varies in the bur from one to three nuts. Owing to size, color, and earliness, the product usually commands \$10 to \$12 per bushel in Philadelphia markets.

MARRON.—Literally "Chestnut." This name is applied to several different types of the European chestnut imported from France. One of the best of these, Marron Combale, resembles the Japanese nut in form, but was introduced into this country from France by Felix Gillet, of Nevada City, Cal.

NUMBO (pl. 14, fig. 11).—Nut large, 40 selected specimens measuring 1 quart; shell bright, smooth, attractive; flavor of kernel equal to the best European varieties, but lacking the sweetness of the American chestnut; skin on the kernel quite astringent. The tree is entirely hardy in Bucks County, Pa., and is a vigorous grower and a fruitful annual cropper. The origin of this variety has been a matter of some doubt, some nurserymen having thought it a Japanese variety because of its peculiar name. We can see no traces of Japanese parentage in this variety, and the following facts furnished by William H. Moon, of Bucks County, concerning its history indicate that it belongs to the European chestnut: "My father, Mahlon Moon, imported a great many chestnut trees at different times from France and some from England. A majority of them were tender and winterkilled, but a very few, perhaps one tree in a hundred, proved hardy and came into bearing. I believe that Numbo is [a seedling from] one of these trees, and by far the best of the lot, all points considered. If it is not an original imported tree, it is a seedling from an imported tree. There were no Japanese chestnuts in this neighborhood until more than thirty years after it had germinated. The name Numbo is not a Japanese word, as some have supposed, but was formed by shortening the name Magnum Bonum, which the elder Moon first applied to the variety."

PARAGON (*Great American*, pl. 2).—This is one of the best varieties of the European type. The nuts are large, measuring from 3 to 4 inches in circumference,

more pubescent than either Numbo or Ridgely. The skin is quite astringent. The quality is good, fully equal to the best of its species. The tree is hardy and productive in Lancaster County, Pa. The original tree was, according to Thomas Meehan, grown by W. L. Shaffer, of Germantown, Pa., from a nut from one of the Spanish chestnut trees then in bearing in the old gardens around Philadelphia. Mr. Shaffer supposed it to have "some American blood," but Mr. Meehan sees no evidence of this in either tree or fruit. The variety was introduced to the trade by H. M. Engle, of Marietta, Pa., about 1888. The colored illustration (pl. 2) represents the variety truthfully.

RIDGELY (*Dupont*, pl. 14, fig. 12).—This variety bears two or three nuts to the bur and ripens about midseason. The nut is smaller than Paragon and with less pubescence at the tip. The skin is astringent, but the flavor of the nut is good. The tree is thrifty and very productive in Delaware and New Jersey. On information received in 1889 this was thought to be a variety of the American chestnut, but an examination of specimens of leaves and fruit since that time shows it to be of the European type. It is one of the hardiest of the large chestnuts. Edward Ridgely, of Dover, Del., furnishes the following history: "It was sent as a sprouted nut in a flowerpot by Mr. Dupont of Wilmington, Del., to my father about 1822. It is a very prolific bearer, producing annually from 2 to 5 bushels of nuts of large size. These sell readily at from \$6 to \$10 per bushel. The largest crop was 5½ bushels, and the highest price received was \$11 per bushel. It has failed to bear only two years and that on account of the rose bugs, which destroyed the blossoms.¹ The original tree is still in a thrifty condition, but I do not think the nuts are quite as large as when the tree was younger. I have had 60 selected nuts fill a quart measure. I have raised quite a number of trees by planting the nuts, but they have never come out like the original."

JAPANESE CHESTNUT (*Castanea Japonica* Blume).

The Japanese chestnut makes a smaller tree than either of the other species, and is a valuable introduction. It has slender branches and handsome foliage, is of compact symmetrical habit, and will be found a useful ornamental tree for small plantations where there would not be room for some of the larger shade trees. Messrs. Parry, of New Jersey, have been the largest importers and propagators of this species. Specimens of five of their selected varieties have been received at this office, and in size surpass all other chestnuts in our collection. In early and prolific bearing this species also leads the others. Like the European chestnut, the kernel is surrounded with a bitter skin which should be removed before eating. The late William Parry fruited many varieties for several years and said of the Mammoth that it never failed to produce good crops, having no off years. C. C. Georgeson says: "There are several varieties in Japan. The Giant, which attains its greatest size in the district of Tamba, is undoubtedly the largest variety of the chestnut in existence. Another variety that is no larger than the common American chestnut grows pretty much all over that country. Besides these the Japanese have a very small variety which they call 'Shibaguri.' The tree is small and scrubby, the leaves are very small, and the nuts scarcely larger than filberts."²

In propagating seedlings from Japanese chestnuts, H. M. Engle says he finds as many varieties as there are Chicasa plums or Russian apricots.

L. H. Bailey says:³ "It is to be regretted that our nurserymen are lumping the oriental fruit off as Japanese chestnuts. This means nothing except that the plants chance to be Japanese in origin, and varieties of widely different merit may be sold

¹The *Rural New Yorker* reports an experiment in June, 1891, where it was found that water at 125° of heat may be sprayed on the flowers and foliage of plants infested with the rose bug, killing these insects thereby and without injury to the plants. *American Garden*, July, 1891, page 421.

²*American Garden*, May, 1891, page 265.

³*American Garden*, May, 1891, page 278.

as one. We should not expect to sell the Old World fruit as simply the European chestnut. A rigid investigation should be made into varieties of the Japanese chestnut and the common and inferior stock upon the market should be destroyed. The best named varieties or types should be imported. One of the largest and best nurseries in the country sold in good faith the common chinkapin (*Castanea pumila*) as Japanese chestnut."

NAMED VARIETIES.

ADVANCE.—A seedling of Giant. Ripens near Philadelphia about September 15. The tree is an upright, vigorous grower, comes into bearing at an early age, and is productive. Nut large, smooth, dark colored; is produced two or three in each bur.

ALPHA.—A seedling of Giant. Originated by William Parry, of New Jersey, and by him considered the earliest known variety of chestnut; very productive. The tree began to bear three years from seed, and has never since failed to produce a good crop. Nuts large, running two to three to the bur. Opening without the aid of frost from September 10 to 12.

BETA.—Another seedling of Giant, very similar to Alpha and ripening immediately after it, or about the middle of September.

BLACK.—Specimens from J. W. Kerr, Denton, Md. Size large; kernel plump, surrounded by rather thick and somewhat acrid skin; quality good for roasting; very productive; season September 10 to 20, in Caroline County, Md. Named in honor of Dr. John J. Black, a former president of the Peninsula Horticultural Society.

COLONEL MARTIN.—Specimens from J. W. Kerr, Denton, Md. Size large; yields five nuts to the bur; quality is that of Japanese seedlings.

EARLY PROLIFIC.—Another of William Parry's seedlings of Giant. It differs from others of these seedlings enough to have earned its name.

EARLY RELIANCE.—Ripens its fruit in a few days after the Advance. The tree is a dwarf of spreading habit and comes into bearing at an early age. Three to five large nuts are produced to the bur. The nuts are smooth, bright, and uniform.

FELTON.—Specimens from J. W. Killen, Felton, Del. A large and very sweet nut, possessing those edible qualities which are lacking in most other chestnuts of the Japanese type.

GIANT (pl. 14, fig. 13).—The tree is upright and a vigorous grower. The nuts are smooth and dark colored, and in size very large. Only from one to two nuts are produced in each bur. Ripens near Philadelphia about September 25.

JUMBO.—Reported by George E. Arnold, of Benton Center, N. Y.

KERR.—Specimens from J. W. Kerr, Denton, Md. This differs from other seedlings produced by Mr. Kerr in that the burs have shorter spines and fewer of them, and the burs do not cast their nuts as freely as the others. Nuts are darker in color, three to the bur. Found to be enormously productive in Caroline County, Md.

KILLEN.—Specimens from J. W. Killen, Felton, Del. A remarkably large and handsome chestnut; in size as large as the largest Japan Mammoth, and in quality superior to most of this type. Yields three nuts to the bur.

MAMMOTH.—The chestnuts received at this office under this name are reported as having been grown on seedling trees from selected seed of the Giant.

SUPERB.—A seedling of Japan Giant, originated by William Parry. A vigorous growing tree, immensely productive, making a mass of burs, of which each generally contains three very large, complete, handsome nuts, ripening in midsummer.

SUCCESS.—One of William Parry's seedlings. Tree upright, productive. Nuts somewhat larger than Advance or Early Reliance. Ripens about September 20.

CHINKAPIN (*Castanea pumila* Miller).¹

The chinkapin may be best described as a dwarf chestnut. It is more or less abundant on sandy knolls and hillsides along the Atlantic Seaboard from Delaware to northern Florida, and westward across Pennsylvania, southern Ohio, Indiana, Missouri, and Arkansas to eastern Texas. Botanists characterize it as a spreading shrub or small tree having oblong, acute serrate leaves, downy beneath, and bearing small, solitary ovoid nuts in small involucre, often spiked. (See pl. 15, fig. 4.) Through Virginia and Tennessee occasional trees are reported that are from 30 to 40 feet in height, having the leaf and fruit of the chinkapin, with the tree and fruiting habit of the chestnut. These have been commonly regarded as hybrids, but from the fact that this tree-form is the prevailing type through southern Missouri, Arkansas, and Texas, it should probably be ranked as a botanical variety of the chinkapin. The chinkapin nut is smaller than the chestnut, but makes up for this defect, in part, by its productiveness and earliness to ripen. It is the first ripe nut to reach the market in the fall, and in consequence sometimes brings higher prices than chestnuts. The acceptable flavor of the chinkapin seems to have been recognized by the aborigines, for in his book Capt. John Smith says: "They have small fruit growing on little trees, husk like a chestnut but with fruit like a very small acorn. This they called Chechinquamins, which they esteem a great dainty."

Though possessing the valuable qualities of dwarfish growth, earliness, and productiveness, and yielding a nut of delicate flavor, there seems to have been but little yet accomplished in the improvement of the chinkapin. The plant suckers freely, and soon becomes a nuisance in cultivated ground, and the nuts are particularly subject to damage by insects. The wide variation in individual trees of the species would indicate that some valuable varieties may yet be found among the many different wild types. An early ripening chinkapin as large as a small chestnut, and as good as some of those that find their way into our city markets, would be a decided acquisition, particularly if the tree was of fair size and free from the suckering habit. There are indications that varieties possessing some of these qualities are already known, and search for the trees bearing choice nuts may well be encouraged. There is reason to believe also that as a stock upon which to graft the chestnut the stronger growing chinkapin would be valuable to nut growers in the South, where the chestnut does not succeed on its own roots. Several experiments in grafting and budding both European and Japanese chestnuts on the common chinkapin in Florida, are reported to be very successful.

O. Bryant, of Longwood, Fla., set dormant scions from a 6-year-old Spanish chestnut tree that had never blossomed in chinkapin stocks on which the buds were just swelling in the spring, using only cotton dipped in beeswax to hold the grafts in place. The grafts started and grew vigorously, blossomed, and one of them set a cluster of fruit, afterward destroyed by twig girdlers, though the graft continued to do well.

C. Murdock, Sorrento, Fla., asserts that Japanese and Spanish chestnuts budded on chinkapin make a growth of 3 inches in diameter in three years.

John B. Carrin, of Taylor County, Fla., cut off young chinkapin bushes below the surface and set grafts of Mammoth Japan chestnut when both stocks and scions were dormant, using no protective covering but soil. He reports that 75 per cent of the scions grew.

¹ *Castanea nana*, Muhlenberg, is segregated by some botanists as a very low growing form (1 to 4 feet) found in North and South Carolina, also in Georgia, Florida, and Louisiana. Its nuts are said to be larger, though fewer in number than those of *C. pumila*. T. H. Kearney, jr., says of it (Bul. Torrey Botanical Club, June, 1894, page 262): "Differs from *C. pumila* in the dwarf habit, broader leaves, which are oblong or obovate-oblong and usually obtuse; in the shorter, more rigid and more spreading teeth; in the shining upper surface of the leaf and the more tawny hue of the down on the lower surface and in the shorter petioles."

MARKETING.

The chinkapin is prepared for market by simply drying the nuts in the sun after picking, to keep them from molding. Scalding, as recommended for the chestnut, would lessen the ravages of the worms in the fruit. Prices received for the nuts are stated by different correspondents to range from 25 cents per "gallon" to 10 and 20 cents per pound. One Tennessee dealer writes that he pays \$4 per bushel for them for shipment.

NOTES FROM CORRESPONDENTS.

A few notes relative to the abundance and value of the chinkapin in different States are appended:

PENNSYLVANIA.—Davison Greenwalt, Chambersburg: "Chinkapins grow along the mountain. Some of them are very fine."

MARYLAND.—J. W. Kerr, Denton: "The chinkapin grows in moderate supply. I find much variation in size and productiveness of trees. I have begun its cultivation in a small way."

VIRGINIA.—C. A. Uber, Virginia Beach: "The chinkapin grows abundantly here. It yields profusely and some bushes bear fine flavored, good-sized nuts. There are some large trees, resembling chestnut, bearing a small bur with but one small nut—a true chinkapin. Of the tree chinkapin there is a specimen in Fairfax County, Va., between Falls Church and the Little Falls."

George W. Johnson, Manassas: "The chinkapin grows wild through the woods and along the roads. It is very productive. It ripens the last of August and sells at 5 cents per quart." (See pl. 15, figs. 3, 3a, 3b.)

NORTH CAROLINA.—F. L. Reynolds, Craters: "It grows in immense quantities. Nuts sell for 10 cents per pound."

M. S. Welland, Wilmington: "A great many are gathered and marketed from here."

TENNESSEE.—J. H. H. Boyd, Cagle: "They are very plentiful in places. I pay \$4 per bushel for them for shipping purposes."

J. O. Grimsley, Otto: "There are two kinds, large and small. A considerable quantity of the small ones grow wild. I know of two trees of the large ones. They seem to be a hybrid with the chestnut. It has the size (in tree and nut) of the chestnut and quality peculiar to the chinkapin." (See pl. 15, figs. 5-7.)

The specimens furnished show it to closely resemble the chinkapin in leaf and in flavor of the nut, but the fruiting habit is that of the chestnut.

John C. Chilton, Otto: "Chinkapins grow in quantity here. I have three bushes of a nut I never saw anywhere else. It just commenced bearing. It seems to be a cross between the chinkapin and the chestnut. I have noticed it carefully, and, as it is surrounded by both chinkapins and chestnuts, I can readily see the difference in growth, bark, leaf, etc. I find it sweeter than any chestnut I have tried, with a slight flavor of the chinkapin. It gets hard slower than either of them. I have not so far found a worm in any of them. I discovered these bushes when clearing land, and preserved them. I have cultivated them the past season, and will continue to do so, as I find them much improved by it. There are four of the trees but only two roots. Three of them are from one root. It must have been burned or cut off some years ago. They are not more than 4 inches in diameter and 12 to 15 feet high. Since I became interested in watching this nut I have learned from J. O. Grimsley that something of the same kind is growing on his father-in-law's place, and I have heard of one other, about 5 miles from here, that was cut down in the clearing."

MISSOURI.—Addison D. Smith, Cassville: "There is a large quantity of chinkapins here. The nuts are dried in the sun or otherwise to keep the worms from eating

them. Twenty-five cents per gallon is the market price. The trees are large here. A few are 3 feet in diameter and 60 feet high. I frequently see them 1 or 2 feet in diameter. As a lasting timber it is only excelled by good cedar."

ARKANSAS.—F. M. Liner, Brightwater: "The chinkapin grows wild here. It seems at home, and is much in character like the chestnut, and it bears well, while we have no wild chestnuts."

E. G. Rhodes, Elixir: "Chinkapin is plentiful in the wild state. There is no market for them."

MISSISSIPPI.—J. L. Barclay, Sandersville: "The chinkapin does well cultivated. I have a choice variety."

E. W. Lyon, Heidelberg: "The chinkapin is a good thing on a worn-out ridge."

LOUISIANA.—G. W. Stoner, Jewella: "The chinkapin grows in places here, and sells for 20 cents per pound."

FLORIDA.—August Leyoraz, Francis: "There are two species of the chinkapin growing along the lakes and on sandy hills. One grows 3 to 4 feet high and the other 25 to 30 feet high."

TEXAS.—D. C. Stuart, Mount Selma: "The chinkapin is the only species of chestnut growing wild in this country."

Otto Locke, New Braunfels: "The chinkapin grows to perfection here, 2½ feet in diameter, but most of the large trees have been cut down. The wood is very durable. The Japanese chestnut has been grafted on it with success."

WESTERN CHINKAPIN.

(*Castanopsis crysophylla* A. D. C.)

[Plate 15, figs. 1 and 2.]

Professor Sargent states the habitat of this nut is "the Cascade Mountains, Oregon, below 4,000 feet elevation, south along the western slopes of the Sierra Nevadas, and through the California coast ranges to San Bernardino and San Jacinto Mountains." In Mendocino County, Cal., and northward, it forms a large tree 50 to 125 feet high and 2 or 3 feet in diameter. The tree has evergreen leaves, smooth and shiny above, but thickly covered underneath with yellow scale. The form of leaf, flower aments, and bur inclosing the fruit is somewhat similar to that found in the chestnut. The fruit is a rounded, three-cornered nut, closely resembling a very large and plump beech nut. It is borne singly in a bur that has divergent, many-branched spines. According to Wickson¹ the most common form is the variety *minor*, a shrub from 2 to 6 feet high, bearing abundant crops of nuts. E. C. Russell, Sweet Home, Oreg., writes: "It is our only nut besides the hazelnut. It is a small evergreen tree, which produces a crop of nuts every second year. The nuts are three-cornered, about the size of a small hazelnut, and have a soft shell. No attempt has been made to cultivate them. The tree is rather small, and seldom reaches 2 feet in diameter. It is most frequently found on stony land, although the largest trees with which I am acquainted are on land which is not stony. It is found only on dry land. The form of growth is equally conical. It is valuable as an ornamental tree, if it can be successfully cultivated. It blooms in June and ripens its nuts in September of the next year. The wood, when it grows large enough, is valuable for furniture and takes a fine polish."

¹ California Fruits, page 59.

PINE NUTS.

(Pinus L.)

This name is derived from the Latin word *pix*, *picis*, and means the tree that produces pitch. The pine nut has a rich marrowy kernel in a shell that varies in thickness from that of a chestnut to that of a hard-shelled hazelnut. Its form and size of nuts of different species vary greatly, as may be seen on pl. 16. The several species of pine yielding edible nuts are found on the Pacific Slope of the United States and in Colorado, New Mexico, Arizona, and Mexico. The nuts are but little known to a majority of the people of the United States, though they are marketed in large quantities in some of the cities of California. Some of them are of good size for dessert or confectionery purposes, and in quality and flavor are so superior that their general introduction will doubtless make them very popular. The pine nuts are generally harvested by Indians, whose method is to heat the cones until they open, when the nuts are easily rattled out, having been roasted in the process. This accounts for the fact that few piñons can be secured in the market in the raw state. When a quantity of the nuts has been secured, the Indians dispose of them at the stores, whence the nuts are retailed in a small way for local consumption. Some are shipped to the larger markets of the cities on the Pacific Coast, and rarely to Eastern cities. Along the borders of Mexico the nuts are called "piñons," and to an increasing extent this name is being accepted as applicable to all pine nuts. To what extent the several species would reward the planter when brought into cultivation is a matter of mere conjecture. As an indication of the extent to which these nuts are gathered, and the esteem in which they are held, a few extracts from our correspondents are given.

NOTES FROM CORRESPONDENTS.

O. P. Chubb, Orange, Cal.: "The piñon is gathered on San Bernardino Mountains in great quantities. They are gathered and sold with profit by Indians and border settlers."

Scipio Craig, Redlands, Cal.: "Piñons are the most plentiful wild nuts. They grow in the mountains and are systematically gathered and marketed by the Indians."

D. S. Grimes, Denver, Colo.: "Piñon pine is found in extensive bodies in western Colorado. It produces edible nuts, which are gathered in large quantities for market."

J. J. Leeson, Socorro, N. Mex.: "The piñon grows to perfection in our mountains, and thousands of pounds are sold, the Mexicans preferring them to all others. They sell, when roasted, for from 10 to 20 cents per pound. Some trees produce as much as 5 bushels. They are fine-flavored and attain the size of acorns."

A. J. Johnson, Astoria, Oreg.: "The pines are all of dwarf habit and grow in high altitudes. The nuts are picked by Indians and roasted in hot ashes until the cones open, when the nuts will rattle out very easily. I have collected seed nuts of *Pinus albicaulis* and *Pinus flexilis* in the Cascade Mountains, near the snow line of Mount Hood, at an altitude of 7,000 to 9,000 feet. The trees make low, dense growth; are compact, and are very ornamental. Some years they are loaded with seed cones."

By the kindness of Prof. J. G. Lemmon, of Oakland, Cal., the herbarium of this division has been supplied with a very satisfactory collection of these nuts. We quote at some length from his interesting pamphlet, "Pines of the Pacific Slope," concerning several species: "The Indians and Mexicans eat a great many kinds of seeds and nuts and roots. Of seeds, they eat those of any of the pines they can reach. Of course, the most desirable are the largest and most abundant species; so, chief of the so-called pine nuts, or piñons, are the long-cone pines, globe-cone pines, and heavy-cone pines. There are other species of pine which bear large and very desirable

seeds, but the trees are so limited in number that their fruit is too scarce to be known to the natives as an article of diet. Of such are the *Pinus albicaulis*, *Pinus flexilis*, and *Pinus torreyana*.

Of the 24 species of pine found on the Pacific Slope, including Arizona, half of them afford seeds that are used as Indian food.

Following the order of species as presented in "Pines of the Pacific Slope," we illustrate and describe some of the most valuable species:

NAMED SPECIES ON THE PACIFIC SLOPE.

MOUNTAIN PINE (*Pinus monticola* Doug., pl. 16, fig. 1).—"Specimens collected in Gold Lake Valley, Sierra County, Cal. Occupying elevated regions mostly of the Sierra and Cascade ranges, this delicious pine seed is rarely seen in the possession of the natives, but it is eagerly eaten out of hand by the males as soon as gathered. Mature cones narrow, 6 to 12 inches long; scales thin, weak, reflexed at maturity."

SUGAR PINE (*Pinus lambertiana* Doug., pl. 16, fig. 2).—"Specimens collected in Sierra Valley at 7,000 feet altitude. Found at lower elevations and in vast quantities. The sugar pine is a prime article of food, large trees being often cut down for their fruit. Mature cones 10 to 12 inches, rarely 15 to 22 inches long, and 2 to 3 inches thick, becoming, when expanded, 4 to 6 inches thick. Seeds very large, about one-half inch long, with large wings an inch long, and thickly veined with reddish brown. There is a variety *minor* (Little Sugar Pine), of which the tree and fruit are small."

WHITE-BARK PINE (*Pinus albicaulis* Engel., pl. 16, fig. 3).—"South shoulder of Mount Shasta, timber line of the trees. Much dwarfed Alpine trees, found on timber line of high peaks. These extremely fat and nutritious seeds become a delicacy well rewarding the hard climb to secure them. Mature cones small, subglobose, one-half to 2 inches long, deep purple until maturity. Seeds pale, nearly globular."

SINGLE-LEAF PINE (*Pinus monophylla* Tor. & Frem., pl. 16, fig. 4).—"Specimens collected on eastern slope of San Bernardino Mountains. This is one of the most noted of the nut pines, and was formerly quite abundant on the low mountain ranges of Nevada and the eastern Sierra foothills. Of late the trees have been nearly all destroyed in the mining sections for fuel. This Nevada pine nut is very large; it has a large shell; cones 2 inches long. The solitary leaves of this species not otherwise known in the pine family."

PARRY PINE (*Pinus parryana* Engel., pl. 16, fig. 5. *Mexican Piñon*).—"Specimens collected in Lower California, on San Rafael Mountains, 60 miles below California boundary. This excellent fruit, being limited in supply and found on a little-known peninsula, is rarely seen in the possession of the natives. It is highly prized for the large seed, soft shell, and delicious kernel."

PIÑON (*Pinus edulis* Engel., pl. 16, fig. 6).—"Specimens collected in New Mexico in 1884; quality of kernel still good in 1895. The Mexican piñon is an excellent soft-shelled nut. It is collected in large quantities for sale, and is shipped as far west as California markets."

ARIZONA PIÑON (*Pinus cembroides* Zucc., pl. 16, fig. 7).—"A large and hard-shelled nut; grows few in number in small cones, on very small, round-headed trees."

YELLOW PINE (*Pinus ponderosa* Doug., pl. 16, fig. 8. *Heavy Pine*).—"Specimens collected in Sierra Valley. This widely distributed species, being in some of its forms in proximity to the aborigines, is often collected when other food is scarce; but the small seeds render it least desirable of all pines as a food. Trees of the largest size, 120 to 200 feet, not rarely 250 to 300 feet; and in diameter 4 to 10 feet, often 15 to 20 feet. Mature cones conical ovate, 2 to 5 inches long."

BLACK PINE (*Pinus jeffreyi* Mur., pl. 16, fig. 9).—"Specimens collected in Lake Tahoe Valley. This is nearly as abundant as the former in the Sierras, and the seeds,

being double the size of the Yellow Pine, are quite often collected by the natives who live in the immediate vicinity; but these two species are not reckoned as staple products. Mature cones elongated, 5 to 6 inches, often 8 to 10 inches long, and half as wide when expanded."

TORREY PINE (*Pinus torreyana* Parry., pl. 16, fig. 10).—"This lone, expiring-species is too limited to be well known; but the seeds are very large (shells about as thick as the shells of hazelnuts), the largest known. Ovate, subcylindrical, one half to three-fourths of an inch long, wings short, very thick at base, and incasing the seed like the setting of a jewel. The trees are usually loaded with cones. Mature cones broadly ovate, 4 to 6 inches long and very heavy, 1 to 2 pounds, with broad, thick scales, armed with short, quadrangular, pyramidal, scarcely pointed prickles. No Indian tribes are now in the vicinity, hence the trees are little utilized. A few small trees, buffeted, often prostrated by ocean winds on the bluffs at Delmar, San Diego County; and a smaller number, about a hundred, detected more recently on the east or shore end of Santa Rosa Island, 120 miles north of the other locality."

GRAY-LEAF PINE (*Pinus sabiniana* Doug., pl. 16, fig. 11).—"Specimens collected in Tehachipe Mountains. Quite abundant on the borders of the great valley of California and dotting the foothills. Formerly much used by the natives, and called in one locality 'Digger pine,' but the Indians nowadays use the white man's flour in preference. Seeds large, subcylindrical, one-half to three-fourths inch long, black, with very thick, hard shell and a delicious kernel. Wings very short, the thick base half enveloping the seed with a broad rim. Mature cones broadly ovate, 4 to 6 inches long."

BIG-CONE PINE (*Pinus coulteri* Don., pl. 16, fig. 12).—"The trees are quite local. Though produced by the largest, heaviest cone known, the seeds are not very large; about one-half an inch long and one-half as wide, but with broad wings one and one-half inches long. Mature cones elongated, elliptical, of matchless size and weight; 15 to 20 inches long, half as thick, and weighing 5 to 8 pounds."

THE COCOANUT.

(*Cocos nucifera* Linn.)

Cocos is from Coco, the Portuguese word for monkey, the base of the nut resembling a monkey's head; *nucifera* from two Latin words, *nux*, *nucis*, nut, and *ferre*, to bear—nut bearing.

The cocoanut was known to the inhabitants of Ceylon 161 B. C., and its milk was then used in the making of cement. Sir James Emerson Tennent says:¹ "This date is thought to be the earliest mention made of the cocoa palm in Ceylon, though a time is indicated when it was unknown in that island, by a statue carved in a rock east of Galle, which tradition says is the monument to the Kustia Raja, an Indian prince whose claim to remembrance is that he first taught the Singalese the use of the cocoanut." The tree grows quite straight to the height of 40 to 50 feet and about 1 foot in diameter, generally leaning away from prevailing winds. It is without branches, but has about a dozen leaves springing from the top, each leaf being from 10 to 20 feet long. The leaves are pinnate, composed of a strong midrib with leaflets on either side nearly 3 feet wide at the base and tapering to a point. Five or six leaves are formed every year, the old ones dropping off and leaving horizontal scars that ornament the trunk. The new leaf is inclosed in a tough, fibrous sheath, which is often used as a strainer, or even for clothing. Flowers appear in the axils of the leaves and are inclosed in a thick, tough spathe which opens on the under side and soon drops off; when this is freshly opened the clusters of small three-parted flowers have a beautiful milk-white appearance, though they soon become yellow. Both staminate and pistillate flowers are on spikes growing from a common footstalk.

¹ Ceylon, vol. 1, page 4361.

The female blossoms of the cocoanut are near the base of these spikes, while the more numerous male blossoms occupy the remaining terminal space. As in most palms, the blossom is beautiful from the great number of florets rather than from any individual grace. In favorable places these clusters are produced about every forty days during the rainy season, and each cluster ripens from five to fifteen nuts, thus affording a succession of fruit the year round on each bearing tree.

ORIGIN OF COCOANUT CULTURE IN THE UNITED STATES.

Because of certain differences observed in the trees and nuts that are found growing along the Florida keys, and of the fact that the cocoanut is often carried from shore to shore in warm countries by ocean currents, it has been believed, and apparently with good reason, that the first trees in Florida came from several sources, probably from nuts that drifted from South and Central America, as well as from Cuba and other West India Islands. At Key West, and about some of the old forts, nuts were planted at an early day and groves were cared for, as certain old trees yet standing bear witness. At Lake Worth there are trees, planted about 1860, that are about 40 feet high, and have been bearing since they were five or six years old. They have never been damaged by cold, although there have been several slight frosts there since they were planted. Of one tree grown on Biscayne Bay it is said that the fruit has a reddish husk; of other nuts it has been claimed that there are two varieties—the green and the yellow. In 1877 a bark freighted with cocoanuts was caught in a storm off the Florida coast and was beached near Lake Worth. From this cargo several thousand nuts were saved, and their satisfactory growth gave an impetus to cocoanut planting in Florida. Of the varietal differences among the cocoanuts grown in Florida, no systematic study has yet been made. The first importation of named varieties of the cocoanut was made in 1889. The Secretary of Agriculture then obtained, through the courtesy of the State Department, two shipments of selected named varieties of East India cocoanuts from the Philippine Islands. These, with two other shipments made early in 1890 (four shipments in all) from the same islands, comprehended 14 varieties, which are believed to be the best of 24 varieties then reported as growing in those islands. In obtaining and forwarding these, the United States consul at Manila, Alex. R. Webb, exercised great care and much effort, as not more than two or three kinds grow in any one district or island of the archipelago, and it was found necessary to send a competent man on a tour of the islands to collect the nuts.

The consignments of nuts were received at the Division of Polomogy in good condition, and were promptly forwarded to Florida to several careful propagators at Manatee, Palm Beach, Key West, Lake Worth and Cocoanut Grove. The varieties were:

Grandes, signifies large ones.
Caputiformis, signifies skull shaped.
Rubiscens, signifies fair, reddish.
Maputi, signifies white.
Pequinitos, signifies little ones.
Cayomamis, signifies rocky, or hard fruit.
Bahan, signifies ———.

Polac, signifies red.
Bosa, signifies probably flowing nut or fruit.
Boraves, signifies ———.
Dajila (*Regia mig.*), signifies hard nut.
Dajila Patot (*Pumila mig.*), signifies soft nut.
Tayomamis (*Sacharina mig.*), signifies sweet nut.
Mamilaris, signifies woman's breast.

Mr. Webb writes: "It is impossible to get an English translation of all the names on the list of cocoanuts, as they belong to various dialects and some of them have no meaning beyond 'cocoanut.' Bahan and boraves are in the Visayas dialect and are unknown to the Tajalo or Ilococ natives here. They may be taken as meaning mill-stones, and perhaps the natives gave them these names as signifying their hardness. Bahan may also mean a rock, head, or skull. The nuts of Mamilaris were procured from the islands of Albay and Misamis. They are of the smallest known variety,

yield very little oil, and are not as agreeably flavored as the larger varieties. The shells are utilized by the natives for making drinking cups and oil dippers, and I am told that some of the more ingenious make very prettily carved teacups of them, using the shells of the larger varieties as saucers. In pursuance of the advice of a native who claims to have had much experience in the shipment of cocoanuts, I have packed this lot in sand, having been advised that this is the proper manner in which to transport them long distances for planting.

"Three smaller nuts are of the Dajila Patot variety, scientific name *Pumila mig*; and three larger are the Tayomamis variety, *Saccharina mig*; all are from the island of Panay. The former is prized by the natives for its tender, juicy meat, and they use the shells for making drinking cups. The latter has unusually sweet and oily meat, and is frequently used by the natives with yams and syrup to form a most delicious preserve or sweetmeat. In my second shipment of nuts I sent 12 of the Dajila variety (*Regia mig*) from the island of Samma; these are similar to the Dajila Patot of the fourth shipment, but are somewhat larger and the meat is less juicy. It may be well for the Department of Agriculture to know there is a difference of opinion between the officials of the Department of Forests and Mountains here and some of the more intelligent natives and mestizos, as to the propriety of giving different names to the cocoanuts of the archipelago; the latter, basing their conclusions upon actual observations and an intimate acquaintance with the cocoanut, declare that there is really but one variety in these islands, and that the various names given by Prof. P. Blanco, in his elaborate work 'Flora de Filipnas,' are intended to designate the condition of the nut and tree at their different stages of development. For instance, they hold that the 'Dajila Patot' and 'Coco Chiquito' describe the nut just after the shell has hardened, and that as it matures the flavor and character of the leaf change as well as the shape of the shell and husk; that all ultimately develop into the 'Cocos Grandes.' Professor Blanco, however, gives 20 distinct varieties, and his statements are corroborated by the officials of the Department of Forests and Mountains, who insist that the native theory is utterly untenable. The Macapuno, which is very rarely found, and which presents in the shell a solid mass of soft, greasy meat that is almost tasteless, is cited as a clearly distinct variety; yet the natives claim that this nut is an accident, and that no tree has ever been encountered that bears it exclusively; that Macapunos are often found on the Limbahon, Tayomamis, and other trees. All cocoanut trees have the same general appearance, and apparently follow the same course of development, but there is certainly a vast difference in the size, shape, and flavor of the nuts sent to market. It seems that the question at issue ought to be readily settled by a little systematic observation and experiment, but it has not been done thus far to the satisfaction of both sides. In absence of any documentary evidence in support of what may be termed 'the native position,' I have assumed that Professor Blanco's conclusions are correct, and have followed the nomenclature given in the latest edition of his work. The experiments with these nuts in Florida will undoubtedly solve the problem."

Tennent says of the five varieties which are distinguished by the natives of Ceylon, one is bright orange in the color of the outer husk, and is known as the King cocoanut. The fluid of this variety is said to be very delicate. The other four varieties vary from light yellow to dark green, and are also distinguished by shape and size. Concerning the effect of environment upon the cocoanut where the soil is sandy and pervious, with a profusion of water from the fresh lake on the one side and the sea on the other, a saline atmosphere followed by the constant tossing of the spray on the adjacent shore, a warm and genial sun and timely rain, this author says of the nuts that grow at Batticaloa, in Ceylon, under such conditions, "The excellence is 50 per cent greater than nuts from the opposite side of the island."

For seed, the cocoanut is allowed to become well ripened on the tree; taken thus, with the husk left on, the nut is planted on its side in a bed of leaf mold in the shade.

In from three to six months the nut will germinate, and may be transplanted when the third and fourth leaf have formed. The tree is also propagated by cuttings, as where the head is taken from a blown-down tree. In Ceylon the nuts are bedded in the nursery, and are covered an inch deep with sand and seaweed or soft mud from the beach. They are watered daily until they germinate. Thus bedded in April they are sufficiently grown to be planted out before the rains of September, when they are set in holes 3 feet deep and 20 to 30 feet apart. It is customary to place soft mud and seaweed in the bottom of the holes on which to set the roots of the plants. For the first two years, during which time the growth is very slow, the plants are watered and protected from the hot glare of the sun. By some planters care is taken to so place the nut that the three black spots on one end are uppermost; the stem rises from one of these to apertures that remain soft, and the shell is soon split.

The fruiting age begins when the tree is from four to twelve years old. After the tree begins to fruit, it continues with increasing yield for seventy-five or eighty years. They thrive in a compost of two parts of rich loam, one part peat and one of sand. They require a copious supply of water during growing season, which should be gradually diminished as winter approaches. With sufficient moisture and good soil, blossoms succeed each other every few weeks, and it is usual to find bloom and fruit in all stages of development upon the same tree. A mature tree will produce about 100 nuts per year; some trees ripen as many as 300 nuts per year. The nuts grow in clusters, five to fifteen forming a bunch.

Florida growers of the cocoanut bury the nuts until they sprout, and then transfer to the field where they are to grow. The field planting is made in holes about 2 feet deep and 20 feet apart. At the bottom of these holes the sprouted nuts are covered with good earth, and as the plant grows, the earth is filled in around the plant till level with the surface. For several years the demand for nuts for planting, at about \$5 per hundred, has exceeded the supply. The tree thrives and is fruitful in proximity to salt water in Florida, south of Lake Worth on the east and Charlotte Harbor on the west, including the keys or islands. The tree begins to fruit in southern Florida in from five to seven years from the planting of the nut. When removed inland it is not fruitful, indeed does not thrive. On Key West there are some trees over fifty years old, and a few trees have been growing for many years at Cape Florida and on Indian Key. On the keys or islands off southern Florida there are many acres of bearing trees, while at Cape Sable, on the mainland, J. A. Waddell has 42,000 young trees; many other planters have groves of greater or less dimensions. At the present time there are on the east coast of Florida about 250,000 trees of all ages, of which 20,000 or 25,000 are in bearing. About 2,500 acres comprise the area just planted. On the shores of Lake Worth there are fully 50,000 cocoanut trees, old and young, now growing. On some of these trees nuts hang within 2 feet of the ground, and there can be nothing more picturesque and graceful than the soft yellowish-green leaves of the cocoanut groves as they wave in the wind which blows almost constantly along these shores. Many of the leaves are from 10 to 20 feet long, and as perfect in every particular as an ostrich plume.

USES OF THE COCOANUT.

The uses and products of the cocoanut palm in tropical countries are very numerous. Roots, trunk, leaf, sap, and nut are made to yield tribute to man in almost innumerable ways. But in view of the limited area in the United States where it is possible to grow it, there is little probability of its extensive planting except for its fruit and the various products obtained from it, including the husk. The husk or fibrous pericarp of the nut, called "coir" (from a Latin word, *corium*, the skin), is employed in various ways. Coir is prepared by soaking the husks for several months in water and then beating them with heavy weights. Forty nuts

usually yield 6 pounds of coir. As coir yarn, it is imported into the United States at a value of about $2\frac{3}{4}$ cents per pound. In Europe, Asia, and America coir is preferred to horse hair for stuffing beds, cushions, chairs, and saddles, as it is indestructible and never harbors vermin. Rope made from coir is very strong and light, does not rot when wet, and floats in water. It is stronger and more elastic than hemp, and before the days of chains, chain cables and wire ropes it was in demand for cables and standing rigging on shipboard.

Door mats of coir find a ready sale at remunerative prices. The Polynesians twist and braid small cords of this fiber, which as "sinnet" serves in the construction of houses and canoes where Europeans would use nails. The small green and immature nuts are grated fine for medicinal use, and when mixed with the oil of the ripe nut it becomes a healing ointment. The jelly which lines the shell of more mature nuts furnishes a delicate and nutritious food. The milk in its center, when iced, is a most delicious luxury. In the Maldivé Islands, labor performed is more frequently than otherwise paid for in cocoanuts alone. Grated cocoanut forms a part of the world-renowned East India condiment, curry. The chief manufactured product derived from the kernel of the cocoanut is cocoanut oil, which has a commercial value of about $6\frac{3}{4}$ cents per pound by the hogshead. Most of the oil consumed in the United States is of home manufacture, though made from imported nuts, the oil being extracted from the dry meat of the nut as imported, either by pressure or by a treatment of sulphide of carbon. Chemically the oil consists of the peculiar substance called cocinin, a complex combination of fatty acids with a very small quantity of olein. During saponification cocinin yields glycerine and cocinic acid; it is therefore mainly valuable in the preparation of candles and soaps. The oil is used in small quantities for fine toilet and fulling soaps, also for marine soap, as it forms a lather with sea water. It is also used in the preparation of a butter substitute, known as cocoanut stearin.

In most cocoanut-growing countries the process of preparing the oil is exceedingly crude. The kernel is either broken up and dried in the sun and the oil extracted by pressure, or exposed to the sun in troughs and kept constantly wet until fermentation takes place, when the oil is drained off. The refuse is fed to pigs and poultry. The poorer natives burn this oil in cocoanut shells, making the wicks of a bunch of fiber from the husks; the wealthier classes pour the oil into brass lamps 4 or 5 feet high, having flat basins with ornamental beaks to hold the wick. Cocoa oil is also used to anoint the body and is extensively employed as a substitute for olive oil in pharmaceutical preparations. Mixed with a species of resin, and the compound melted, a substance is obtained which is used in India instead of pitch for calking the seams of boats and ships. It is also used as a substitute for wax in the manufacture of fine candles. It is said to be preferred to olive oil by cloth manufacturers and glass blowers. The kernels broken and dried are known as copperah or copra; 1,000 full-sized nuts will yield 500 pounds of copra, from which 25 gallons of oil should be obtained. The oil is a white substance of a peculiar, disagreeable odor; liquid at 80° ; below this temperature down to 50° it is of the consistence of lard, and cooler than that it is quite solid. Under pressure it separates into a liquid and a solid portion; the latter, cocoa stearin, is extensively used in the manufacture of candles.

COCOANUT BUTTER.

Mr. J. C. Monaghan, United States consul at Mannheim,¹ called attention to the fact that quite an extensive factory in that city is manufacturing cocoanut butter, of which the consul suggests: "If it is what chemists and hospital supervisors say it is, its manufacture in the United States, where such vast quantities of butter are

¹In Vol. 108, Consular Reports, Department of State.

consumed, should be undertaken." Mr. Monaghan does not give any particulars of the method of its manufacture, and careful inquiry by this Division leaves the impression that the particular method is a secret of the Mannheim manufacturer. The discovery was made by a German chemist named Schlunk, of Ludwigshafen, near Mannheim. Liebig and Fresenius had before discovered the value of the cocoanut oil or fat, but did not succeed in its production as a substitute for butter. Shortly after the discovery of the new article called cocoanut butter a firm was established for its manufacture, which, the consul says, sunk a large amount of capital. However, in the summer of 1889, when the company had been established but a year, he says the demand was in excess of the supply. Twenty-five workmen were employed by the firm, at wages ranging from 25 to 75 cents per day. These workmen, with the aid of a 40-horsepower engine, produced about 6,600 pounds of butter per day, that retailed at about 13 to 15½ cents per pound. The nuts are obtained especially from the South Sea Islands and Coral Islands, Arabia, and the coast countries of Africa and South America. The butter is of a clear, whitish color, so rich in fat that of water and foreign substances combined there are but .0068. It is better adapted for cooking than for table use. At present it is chiefly used in hospitals, but it is rapidly finding its way to the tables of the poor, particularly as a substitute for oleomargarin. It is, of course, free from germs of tuberculosis, which is said to afflict fully 10 per cent of the milch cows in Germany.

ENEMIES OF THE COCOANUT PALM.

The cocoanut palm is said to be especially liable to injury from lightning, due, no doubt, to its lofty growth in warm latitudes. A lightning stroke kills the terminal bud, and death to the tree ensues. Probably the most annoying pest among cocoanut walks is the black rat of those sections, which delights to build its nests in the fruiting trees. In sections where these rats abound they destroy thousands of the tender young nuts and have become one of the most serious troubles of the cocoanut planter. The most satisfactory protection against these, thus far reported, consists in incasing the trunks of the trees with broad sheets of galvanized iron, taking care to run the sheet-iron casing so high that the rats can not possibly jump to the body of the tree above. All intermediate or pendent growth likely to serve as ladders for the rats to go up must be removed. When the guards are in place to prevent the rats from climbing the trees, search is made throughout the tree-tops to drive out any that may be hidden among the branches. Sandwiches of bread and phosphoric paste deposited among the leaf-stalks, and in proximity to the nuts have been found efficient help.

INSECTS OF THE COCOANUT PALM.

An insect called Black Beetle preys upon the terminal leaf bud, from the injury of which the tree often dies. United States consul Otto E. Keimer, at Santiago de Cuba, writing to the Department of State, under date of December 6, 1889, says: "Small shipments of cocoanuts are leaving this port almost continuously for the United States, and there is probability that some of these cocoanuts are used as seed. I have, therefore, with much interest watched the scientific observations made at Havana, Baracoa, and here, with the object of discovering the origin of the mysterious disease which is killing many cocoanut palms, and which at one time threatened to almost annihilate all the plantations producing cocoanuts for market and export. Opinions of scientists have differed as regards the cause and nature of the disease, Professor Ramos, of Havana, ascribing it to a fungous growth on the base of the leaves, which growth penetrates the crown of the tree, withering and killing it. This theory is proved to be incorrect, and it is now definitely ascertained that the destroyer of the cocoanut tree is an insect of dimin-

utive size, barely visible to the naked eye, the *Cocos diaspis vandalicus* de Galvez. Professor Gundlach, of Havana, at present here, recommends that all cocoanuts as soon as received in the United States be dipped into boiling water and that the bags they are shipped in be destroyed."

In Ceylon, Sir Emerson Tennent reported the cocoanut beetle (*Batocera rubus*) as among the most destructive enemies of the cocoanut palm. These penetrate the trunks of the younger trees near the ground and deposit their eggs. The grubs when hatched eat their way upward through the center of the tree to the top, where they pierce the young leaf buds and do incredible damage. The larva is of large dimensions, and after perforating the tree in all directions it forms a cocoon of the gnawed wood and sawdust, in which it reposes during its sleep, as *pupa*, till the arrival of the period when it emerges as a perfect beetle.

NOTES FROM FLORIDA CORRESPONDENTS.

James McFarlane, Lake Worth (May 6, 1889): "From nuts planted in July, 1882, I send you specimen cocoanuts. The tree has 110 more on, which are maturing beautifully. I have several more trees with lots of nuts on. The only way I can account for such early and rapid growth must be in the richness of the soil. I am quite convinced that a cocoanut should be planted where it is to remain. Transplanting throws them back at least a year in growth."

George W. Lainhart, Palm Beach: "I have about 500 cocoanut trees; about 250 in bearing. Yield from 1 to 100 a year. They sell here at 4 cents apiece for seed."

William M. Lanetart, Figulus: "I have 2,000 cocoanuts bearing, 12 years old. Average yield, 100 nuts yearly; average value here, \$40 per thousand."

J. H. Brelsford, Palm Beach: "Cocoanuts are cultivated and are bearing well; we have no market established; all nuts ripening are in demand for planting."

E. M. Denick, Palm Beach: "I have 3,000 cocoanuts, 800 in bearing, on all kinds of land; do well on both high and low land. Have never marketed any nuts except at home for seed."

George S. Rowley, Lake Worth: "Probably there are 5,000,000 cocoanut trees in this (Dade) county, growing in different stages—from nuts just started to old bearing trees. Of the latter, not more than 4,000 or 5,000 in the whole county. Many young trees are on lands of nonresidents or winter residents. Nuts formerly sold here at 10 cents each, but now are slow sale at 5 cents each, and are bought generally for planting. No outside market has yet been found, but as trees are fast coming into bearing the marketing is demanding consideration."

MISCELLANEOUS NUTS.

BEECH (*Fagus atropunicea* Sudworth; *F. ferruginea* Ait).

The American Beech, though not planted for its nut, is in many sections so abundant in our forests that its fruit is gathered in considerable quantity both for home use and market. Woodsmen and woodworkers recognize the distinction between different beeches based on differences in color, texture, and comparative size of the heart wood of different trees, calling them "White beech" or "Red beech," as the case may be. Botanists at the present time find no constant characters, however, that enable them to recognize more than a single species, named above. It is widely distributed, being found, according to Sargent, from Nova Scotia and the valley of the Restigouche River to the northern shores of Lake Huron and northern Wisconsin, south to the Chattahoochee region of western Florida and the valley of the Trinity River, Texas, west to eastern Illinois, southeastern Missouri, and Madison County, Ark.

It is a large tree, very common, but rather a slow grower, except on rich, warm soil. The blossoms appear with the leaves, the staminate ones in roundish catkins, pendent on slender stalks, 1 or 2 inches long from the axils of the lower leaves; the pistillate blossoms usually in pairs on the hairy foot stalk from axils of the upper leaves of the season. The triangular small nut is in outline much like a grain of buckwheat. (pl. 15, figs. 10-12.) In flavor and quality the kernel somewhat resembles the hazel, and where full-meated is a most acceptable dessert nut, popular for hotel tables. The substance of the shell is much like that of the chestnut, and in size the beechnut corresponds with the smaller chinkapin. Though hundreds of bushels of the nuts are harvested from forest trees in some localities during exceptional years, they do not enter with any regularity into commercial transactions. As a fattening food for poultry and swine, the beechnut has a history that antedates the Christian era. Its improvement by selection and culture would be a work of years, yet it might repay the labor if the resulting nut could be grown larger and of its present acceptable quality. Experiments would be much facilitated if a variety of dwarfish habit and precocious fruiting could be found. The nuts are usually produced in alternate years, but the trees of some sections are annual bearers of good crops, while in other localities the beech is reported as bearing full crops only on an average of one year in five. Where systematic harvesting is attempted, sheets are spread under the tree and the nuts are jarred, shaken, or poled from the tree on these sheets.

OAKS (*Quercus* L.).

The acorns of some oaks were used by the Indians as food, and are yet valuable in some sections as food for swine, which are allowed to roam at large in the forests. None of the oaks have been cultivated for this purpose, and, with the possible exception of Pin Oak (*Quercus palustris* Du Roi), none are regarded as sufficiently promising to justify their experimental planting for this purpose.

Several correspondents in Indiana commend the quality of the acorns of the Pin Oak, and regard it as worthy of attempts to improve it. Under the name Bayotis, many acorns are reported to be sold along the Mexican frontier of Arizona and New Mexico. Of the bread that is made by the Indians from the flour of the acorn, it is said that it looks and tastes like coarse black clay which has been sun-dried—a statement which we are ready to believe without testing.

HORSE-CHESTNUTS (*Æsculus* L.).

Though the botanical name of the genus was derived from a Latin word meaning nourishment, the nuts of most of the species of this genus are positively harmful, causing death when used as food by man or other animals. *Æsculus flava* Aiton, commonly called Sweet Buckeye, found in the rich woodlands from Virginia to Missouri and southward, and *Æsculus californica*, a dwarf species on the Pacific Coast, are barely edible. As such, these nuts, with many others of indifferent quality, were used as food by the American Indians. To render the California nut edible, the Indians pulverized it and then washed it freely with water to remove the bitter principle, after which they baked it into bread. In this way they used large quantities of them. But their use is now abandoned for that of the white man's bread. Aside from superstitious uses of the nut—to cure most of the diseases to which man is subject—they have been sometimes used in the South instead of soap, to wash woollen goods.

As an ornament the horse-chestnut is worthy of planting in large grounds, either singly or in collections, but as producers of food even the edible species are valueless.

GINKGO (*Ginkgo biloba* L.; *Salisburia adiantifolia* Smith).

(Synonym: Maidenhair tree.)

This, the maidenhair tree of Japan, bears a nut of rather inferior quality, though it is said to be used for food in China and Japan. For ornamental purposes the tree has been quite extensively planted in the United States. It is entirely hardy at Boston. It is readily propagated from seeds or from cuttings or layers. The male and female flowers are usually borne on separate trees, yet Messrs. Ellwanger & Barry, at Rochester, N. Y., have a solitary tree that was planted in 1860, which is reported in the American Garden, May, 1891, as having borne a peck of fruit for three years in succession. The male flowers are in slender catkins about $1\frac{1}{2}$ inches long; the female flowers, sometimes as a single fruit stalk, sometimes as clusters, are naked ovules without perceptible organs. These ovules are usually borne in pairs at the terminus of a stem or catkin, each in a cup-like disk. Generally but one of the ovules matures. In appearance a branch full of the growing fruit resembles very closely a well-filled limb of medium-sized immature plums. The tree is unlike other coniferae in its habit and foliage, and has the peculiarity of not developing the embryo in the seed until after the fruit has fallen from the tree. It is rather tardy in coming into bearing, and as yet there has been no attempt to make use of the limited supply of nuts produced, except by planting. The outside fleshy coating is exceedingly acrid and has a disagreeable odor. It should be entirely removed before attempting to use the kernel, which constitutes the edible portion. The Japanese roast them like chestnuts for eating out of hand, or cook the kernels much as we do green peas. Both tree and fruit are free from insect pests.

KOLA (*Sterculia acuminata* Beauvois).

(Synonyms: Bissy, Goora nut, Ombeme nut.)

A tree of moderate height, likened by some to the chestnut and by others to the orange. It resembles the orange in its habit of bearing flowers and fruit continuously, while its simple leaves, 6 or 8 inches long, resemble those of the chestnut. Its flowers have a pale-yellow calyx, but are without petals. A treatise issued by the government of Jamaica says: "Each fertile flower produces five pods, and as the pods contain each from five to twelve seeds, a single flower may yield 54 seeds, measuring a quart and weighing $1\frac{1}{4}$ pounds."

These nuts are the product of several species of the genus *Sterculia*. The trees grow from 30 to 60 feet high, and in general aspect resemble the chestnut. They are natives of western Africa, in the hot, moist lands lying between the Sierra Leone and the Congo or Lower Guinea and reaching in the interior for 500 or 600 miles, following the limits of the palms. On the eastern coast of Africa they have been introduced by the English. Dr. Schweinfurth says that an imposing form of kola, called by the natives kokkoroku, predominates among the vegetation near Lake Nyanza. It is supposed to have been taken to the coast of Venezuela and to Martinique and other western islands by African negroes when carried from their homes into slavery. Of the several species of *Sterculia* bearing kola nuts, the one most highly prized is *Sterculia acuminata* (of Beauvois), or the *Kola acuminata* (of Robert Brown). The nuts are of oblong shape, three forming a ball like a very large horse-chestnut, fully 2 inches in diameter. The nut has a rugged dark-brown surface. Inside they are light-brown, tough as wood, and have no flavor. From a report of the Botanic Gardens of British Guiana for 1890 we learn that the seed of the kola takes three or four months to germinate, being very slow in the operation. Yet it very quickly loses its vitality under unfavorable conditions. When packed in damp cocoanut fiber it will retain its vitality for several months, and this is one of the best materials in which to pack nuts for transportation. If packed alone the green nuts perish and ferment in a few days. They also perish if kept dry. The Florida Agriculturist of

February 18, 1891, says: "The kola tree commences to bear within four years from the time it is planted, and when it is 10 years old it is in full bearing. The trees bloom and bear at the same time, and the nuts are gathered twice a year—in November and June. The ripe nut consists of a brownish-yellow capsule inclosing both red and white seed, which vary in number from five to fifteen. They are collected with great care by women, who remove the husks and pick out all the damaged seed. The sound seeds are placed in dark baskets lined with leaves, and are then ready for transportation." The editor of the Florida Agriculturist, for March 9, 1892, says: "We have nothing upon which to base our hopes that the plant will succeed in Florida except that the plant grows in a climate similar to ours, in soil resembling heavy hammocks."

Situation.—A treatise on this subject by the government of Jamaica says: "Wherever bananas, nutmegs, or cocoa grow, kola will flourish. Hot, damp situations where rainfall is not less than 80 inches suit best. The tree grows in Jamaica in suitable situations at elevations varying from sea level up to 3,000 feet, but probably it succeeds best below 1,000 feet."

Soil.—A deep, rich, somewhat clayey soil will doubtless be favorable for production, but the kola tree is hardy and will endure variations in soil as it does in climate.

Planting.—Young plants are obtained by planting the seeds either where the trees are to be permanent, or in nurseries to be transplanted. The latter is the better plan. Nicholson's Dictionary of Gardening says this tree may also be propagated by ripened cuttings placed in sand under a hand glass in bottom heat. The soil of the nursery beds should be a mixture of loam with peat or decayed leaf mold. The seeds may be planted at distances from 9 to 12 inches apart, and should be shaded. The seedlings may be transplanted when they are from 2 to 3 feet in height. Their permanent situations should not be less than 25 feet apart. If the soil is not very deep and rich, holes should be dug 3 feet every way some time before planting, and only surface soil filled in. Shade for the plants is necessary, and this is best obtained by growing bananas alternately with the kola.

C. Moss, writing from Demarara, British Guiana, under date of April 5, 1892, says: "I have on my cocoa plantation on the Demarara River 2,700 kola trees which were planted in 1888. In appearance all are healthy and strong; some are 25 feet high. They are said to bear fruit in the sixth or seventh year after the seeds are planted. The seeds I planted were obtained from the British West India island Granada, where the plant is supposed to have been introduced by one of the African slaves. The first lot of seeds I received (1,500) were sent in a box without any holes, packed in damp straw, but none of these seeds grew. Then I sent another order for 3,000 seeds, and requested the shipper to have the seeds packed in a box with some of the earth taken from under the trees from which the seed were procured, first having about ten holes of about a quarter of an inch each, bored in the sides of the box; and when filled the contents were well watered with good fresh water and shipped. From the date that the seeds were so packed to the date I received them was fifteen days, when I found the seeds in excellent condition for planting. I then had the contents of the box watered daily, and ten days after the arrival I had the seeds planted about 25 feet apart on my cocoa plantations. Two thousand seven hundred of the seed grew, and are the same I have already mentioned. I had thought they should be planted under some shade, and therefore planted 2,000 of the seeds under the shade trees used for the cocoa, and 1,000 without shade. Those I planted under shade all grew, and of those I planted without shade but 700 grew. The former are now the finest trees I have, and the latter came on so badly that I had to plant shade trees to protect them. Since the shade trees have been able to give some protection from the sun the kola trees have much improved, but in appearance they are fully two years in growth behind trees which were planted under shade. The shade tree I have is of very rapid growth, and on good land will attain the height of 15 to 20 feet

in three years. I plant the shade trees 26 to 30 feet apart, and, if necessary, after the fourth or fifth year remove some of them. A kola tree is said when fully grown to produce 150 pounds of nuts annually. The nuts are worth at present in the English market 36d. per pound in the raw state. Made into a paste they are considered by the medical faculty of great value as an article of food for invalids and persons having weak digestion. The nut eaten in its raw state is known to be a powerful antidote for alcohol on the human system.

"By the people of Africa it is stored as we do corn, and is valued as an article of food. It is also said to be used among the people in the form of a decoction as a remedy or cure for yellow fever. I believe from what I have seen that the kola tree will flourish best on low, damp land, if well drained. I have been informed by an old African who works on my cocoa plantation and attends to the kola trees that there are two kinds. The kind that I have divides the nut in two, like an oyster shell; the other divides in four, as it were, across the oyster shell. The latter is considered the better for food. The former is also used for food, but is of more value taken as a decoction for fever."

Yield.—The tree will begin to bear at five or six years of age, and will be in good bearing at ten years. It should yield then about 120 pounds of nuts.

Curing.—The seed should be thoroughly dried in the shade if possible, but if there is dampness in the air, the drying must be done in the sun. Unless the seeds are dried perfectly they will decay when shipped. All inferior or worm-eaten seeds should be picked out, to form a second quality.

Dietetic value.—The Kew bulletins for November, 1890, in a lecture on the kola nut by Dr. Neish, published by the Institute of Jamaica, enter fully into the question of its dietetic value. Dr. Neish says that the nuts furnish a nutritious and stimulating beverage. Rich in the active principle of coffee, containing also a large portion of theobromine, the active principle of cocoa, these nuts in addition contain three times the percentage of starch contained in chocolate; they contain less fat, so that in addition to stimulating and nutritious properties it is probable that chocolate prepared from them will more readily agree with delicate stomachs. What enhances the value of kola nuts is the fact that caffeine—a medicine now much employed for the relief of seasickness, megrim, and other nervous complaints—can be readily obtained from these nuts, for the reason that the nuts contain more caffeine than do coffee berries; and in the kola nut the caffeine is in the free or uncombined state. An excellent article of kola chocolate has been produced for the director of the Public Gardens in Jamaica by Prudencio Bravo, of Kingston. Concerning this chocolate, of which a specimen was requested by the Secretary of Agriculture, the director replied, under date March 7, 1892: "It is rather a matter of experiment, as Mr. Bravo is in only a small way of business and will not manufacture on a large scale. The process is simple, consisting in grinding the seeds and mixing with sufficient cocoa fat, or even lard, to render it capable of working into cakes. It may be pure or mixed with varying quantities of cocoa." The Gardener's Chronicle says: "In the form of a drink it is very serviceable, as we can testify, in obviating and lessening the fatigue of prolonged mental exertion. There is no fear of ill results, but there is a probability that it will be an excellent substitute for beer."

From the United States Surgeon-General's Office in Washington, D. C., it is learned that as yet the kola has been but little used in this country, but that the results obtained in Europe warrant a more careful study of the merits of this nut than it has yet received in this country. Nicholas Pike says in the American Agriculturist for December, 1891: "The kola nut has been largely in use for centuries among the natives of Africa. They consider it so valuable that those who have no trees in their own territory will pay by barter for the nuts, either dry or in powder, even their weight in gold dust."

CASHEW (*Anacardium occidentale* L.).

This is a tropical plant, but has fruited in southern Florida, into which State Colonel Codrington, of De Land, introduced it. The nut is about an inch long and is kidney shaped. It is borne on the thickened end of the pear-shaped fleshy stalk. This stalk is sometimes eaten, but it is said to be less pleasant in flavor than the inferior kinds of the mango, which is surely not a high commendation. It is suggested by Woodrow, in his Gardening in India, that if the trees which bear only the best flavored fruit were propagated by inarching as the mango is, a welcome addition to esteemed kinds of fruit might be obtained.

The tree is of spreading habit of growth and enjoys a moist climate. The outer covering of the nut consists of a shell within a shell; the outer one being smooth and ash colored. Between the two shells is a caustic black juice. The kernel is oily, very pleasant in flavor, and wholesome. It is in common use as an article of food in tropical countries, being made into puddings, roasted, and in various ways prepared for the table. A black gum, similar in character to gum arabic, exudes from the bark. It has produced fruit at Lake Worth, Fla., specimens of which were received at this office. In the United States it has been grown more as a curiosity than for its fruits.

LEECHEE (*Nephelium litchi* Cambess).

This fruit is best known in the United States as "Litchi" or "Leechee" and as it is a product generally on sale at the Chinese shops in different cities it is also called Chinese nut. Thus obtained it is in its dry state, round in form, with a rough, thin, scale-like brittle rind or shell, of a dull brown color, and pulp or aril that is brown and sweetish, surrounding a rather large central seed. In select varieties this fruit is in size as large as a hen's egg; and in its fresh state, when the pulp is whitish or tinged with pink, it is said to have a refreshing acid taste. The tree is of small growth with evergreen lanceolate leaves and small greenish white flowers. It is a native of China and is being tested in Florida, where it proves to be tender, and where it offers but little encouragement of withstanding even occasional frosts. In India, the tree is said to love moisture and to thrive only where there is an equable climate and absence of hot winds. Theodore L. Meade, of Oviedo, Fla., writes that this tree grows well there, but suffers much from frost. In the winter of 1888-89 a temperature of 27° cut his tree back but little, while 21° killed it to the ground in March, 1890. Specimens of this fruit that were grown by Charles Amory, at Sanford, Fla., were on exhibition at the rose and strawberry show of the Massachusetts Horticultural Society, June 26, 1883, of which Robert Manning says: "I tasted it and found the flavor excellent. The dry, dark-colored pulp of the dried fruit is, when fresh, a light-colored gelatinous pulp."

RAMBUTAN (*Nephelium lappaceum* L.).

The Rambutan, or Rambostan, of India is an Indian tree belonging to the same genus and produces a fruit similar to Leeches. In California and Florida either ought to succeed where the other is found to be hardy. It has not yet been tested in this country.

TALLOW NUT (*Stillingia sebifera* Michx.).

This tree was introduced from China and is growing near the coast in South Carolina and Georgia, where it attains the height of 20 to 40 feet. The tree may be propagated by cuttings. The nut is best appreciated in China, where alone its products are properly prepared. Those interested may find in the United States Agricultural Report for 1851, pages 54-59, an instructive letter from Dr. McGowan on the methods of elaborating the product of this nut in China. The nuts yield 30 per cent of oil suitable for lamps, though inferior to some other vegetable oils for this purpose. The most valuable portion is the tallow, of which there is a yield of 8 per cent.

CATAPPA (*Terminalia catappa* L.).

One of the species of the Myrobolan tree. The tree attains a height of 60 to 70 feet in localities free from frost, but it is easily killed by cold. Fine specimens have been completely killed in southern Florida by the occasional cold to which that section is subject. The oily, edible seeds are borne in the almond-like shell or husk, which has caused the tree to be sometimes called "Tropical almond" and sometimes "Malabar almond tree." It is not an almond, nor is it likely to be found worthy of cultivation even in the warmest sections of the United States except as an ornamental tree. For the latter purpose it is unique with its "autumn leaves without frost," as at many seasons of the year its large oblong leaves are richly colored yellow and scarlet.

CREAM NUT (*Bertholletia excelsa* Humb. & Bonpl.).

This is a common nut in our markets, brought from Brazil; hence it is often called Brazil nut. The nut is triangular and has a dark-brown rough exterior. The kernel is richly flavored and oily. It seems proper to mention this nut in order to emphasize the fact that the tree is too tender for growth anywhere in the United States. Careful search has failed to discover a thrifty specimen of this tree in this country. Repeated failures to grow it in southern Florida seem sufficient evidence that it will not prosper there. The following is a sample: J. P. Murdock, Oxford, Fla., says: "I have one Brazil-nut tree 4 years old. It is tender and does not prosper."

CHILEAN NUT (*Guevina avellana* Molina; *Quadria heterophylla* Ruiz. & Pav.).

Ferd. Von Mueller refers to this tree as one of the most beautiful in existence, and no one will deny this when he sees the tree, even without flowers. The large pinnate, evergreen leaves are a dark-green, glossy color, shining from afar, and the young purplish buds are clothed with a thick down; add to this the snow-white flowers of the delicate structure peculiar to *Proteaceae* hanging in profusion all over the tree and you have a sight not easily forgotten. Besides its beauty this tree is very useful. Its fruit has an agreeable nut-like taste, but, like the Brabejum, it is poisonous in its raw state. It has proved perfectly hardy at Berkeley, Cal., and is of comparatively rapid growth when established. Though most easily propagated from seeds, this tree can also be propagated by cuttings, as has been done at the Garden of Economic Plants, in Berkeley.

QUEENSLAND NUT (*Macadamia ternifolia* F. von Muell.).

The Queensland-nut tree is a very beautiful evergreen. The fruit is a kind of drupe, perfectly round and smooth, with a fleshy exterior encircling a hard shell like a walnut. The kernel is quite free from the shell and is remarkably rich and agreeable in flavor, which is much like the filbert, but very superior to that nut. The tree is easily raised from seed, and is perfectly hardy along the coast, where the climate is mild. At Berkeley, Cal., it is a little slow the first two or three years. It grows to the proportions of a tree 30 feet or more in height, with leaves from 4 inches to 12 inches long, arranged in whorls of three or four, short stalked, leathery, shining, oblong or oblong lanceolate, entire or dentate at the margin.

BETEL (*Areca catechu* L.).

This nut is the seed of the handsome tropical palm *Areca catechu*, too tender for growth in the United States. The fruit is about the size of a hen's egg, of a reddish-yellow color, and with a thick, fibrous rind inclosing the seed. This seed or nut is about the size of a nutmeg, conical, and flattened at the base, brownish externally, and internally mottled like a nutmeg. It is popular in India, where it is native, and it is calculated that 100,000,000 people use this nut by chewing it the same as tobacco. Its effect is stimulating to the nervous system, like tea, coffee, or tobacco.

PISTACHIO (*Pistacia vera* L.).

This little nut, sometimes called green almond, is about as hardy as the almond, and may be expected to thrive in similar locations. The tree is dioecious, and care is therefore necessary that male as well as female trees be planted. The reddish, oval nut is about as large as the olive; it is slightly furrowed on the surface, and has an oily, green kernel of mild and agreeable flavor. It is much used by confectioners for flavoring and coloring confectionery, and in France for seasoning sausage and other meats. Most of our supply comes from the Mediterranean regions, but, though somewhat larger, they are said to be inferior in flavor to those from Persia.

A native of Syria, this nut has been gradually carried westward, and in some portions of southern Europe has become so far naturalized as to appear indigenous. In England it bears when protected from the cold of winter, but does not ripen well from lack of heat in summer. It is grown in Europe mainly by grafting on the "turpentine" (*Pistacia terebinthus* Mill.) as a stock, for upon its own roots it makes but a slow growth and is a low shrub. It was introduced into the United States in 1854, and was widely distributed through the Southern and Middle States by the Commissioner of Patents, Hon. Charles Mason. Probably the first crop of this nut grown on the Pacific Slope was produced in 1881 on trees belonging to G. P. Rixford, of Sonoma, Cal. The trees were imported from the north of France in 1875. They are small (about 8 to 12 feet in height), but are thrifty and vigorous. The nuts are borne on the female trees in clusters somewhat like grapes, but more scattering, and are covered by a thin, purplish light-green husk. Its culture may well be tested further in California.

PLATE 1.

PECAN.

(*Hicoria pecan* Britton. Synonym: *Carya olivæformis* Nuttall.)

Variety Stuart; wood, leaves, and ripe nuts furnished by the late W. R. Stuart, Ocean Springs, Miss.



PECAN
(Hicoria pecan.)

PLATE 2.

CHESTNUT.

(*Castanea sativa* Mill. Synonym: *Castanea vesca* L.)

Variety Paragon. Synonym: *Great American*. Wood, leaves, and ripe nuts furnished by H. M. Engle, Marietta. Pa.



JULIUS BIEN & CO. LITH. N.Y.

PARAGON CHESTNUT
(*Castanea Sativa*.)

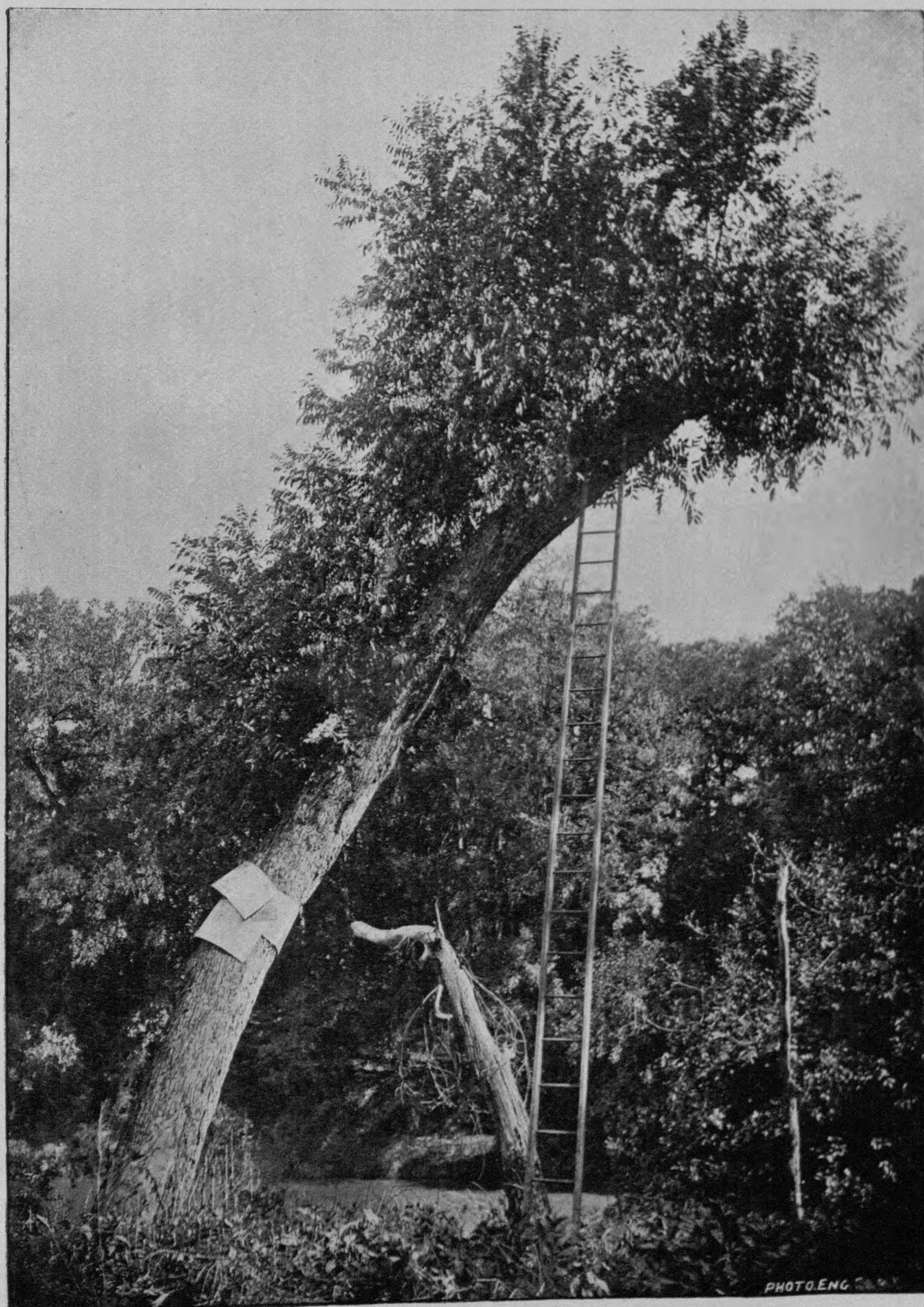
PLATE 3.

A TOP-BUDDED PECAN TREE.

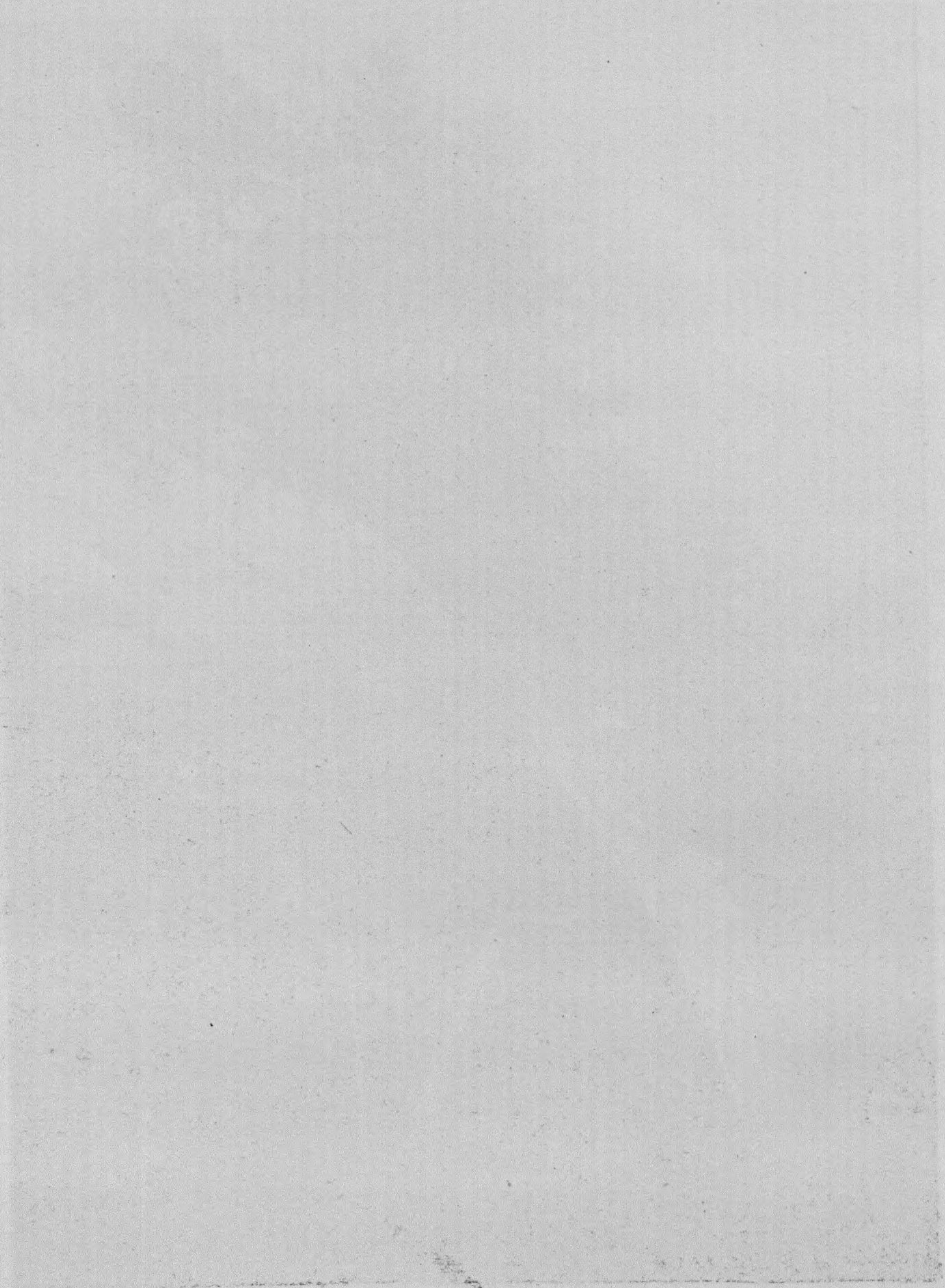
This wild tree was "topped" or cut back in March, 1889. The young shoots resulting from the topping were ring-budded with five choice varieties in June, 1889, in the manner described on page 55.

The photograph was taken in October, 1892, showing four seasons' growth from the buds. Many of the young shoots from the inserted buds were bearing nuts at that time. The ladder leaning against the tree is 24 feet long. The tin guard surrounding the trunk is used to protect the nuts from squirrels; it is made from old tin oil cans.

Mr. E. E. Risien, of San Saba, Tex., who budded the tree and furnished the photograph, has by experiment established the fact that this method of propagation is practicable even with large pecan trees in western Texas. He states that he selects curved or leaning trees, like that shown in the plate, whenever practicable, as they are easily topped and yield a larger number of shoots suitable for budding.



WILD PECAN TREE, TOP-BUDDED.



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PLATE 4.

ALMOND.

(*Amygdalus communis* L.)

- 1. Languedoc.
- 1a'. Languedoc, kernel of 1.
- 1. Languedoc, containing double kernel.
- 1a. Languedoc, section of 1.

Specimens from Ellwood Cooper, Santa Barbara, Cal.

- 3. Ne Plus Ultra.
- 3a. Ne Plus Ultra, section of 3.
- 3a'. Ne Plus Ultra, kernel of 3.
- 4. IXL.
- 4a. IXL, section of 4.
- 4a'. IXL, kernel of 4.
- 5. La Prima.
- 5a. La Prima, section of 5.
- 5a'. La Prima, kernel of 5.
- 6. Nonpareil.
- 6a. Nonpareil, section of 6.
- 6a'. Nonpareil, kernel of 6.

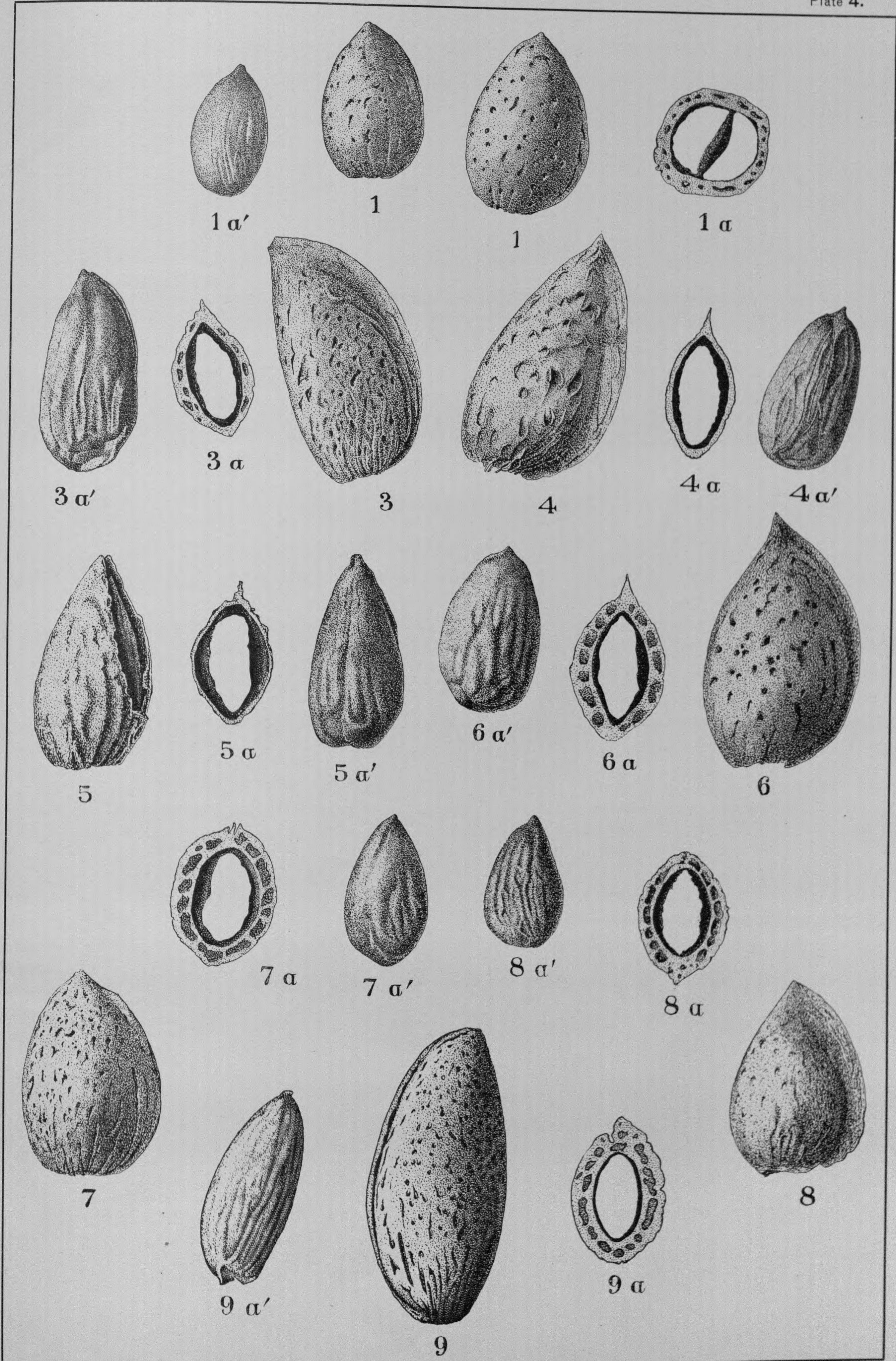
Specimens of 3, 4, 5, and 6 grown in Solano County, Cal., were received from A. T. Hatch, Suisun City, Cal.

- 7. Golden State.
- 7a. Golden State, section of 7.
- 7a'. Golden State, kernel of 7.
- 8. Bitter.
- 8a. Bitter, section of 8.
- 8a'. Bitter, kernel of 8.

Specimens of 7 and 8 received from Leonard Coates, Napa, Cal.

- 9. Jordan.
- 9a. Jordan, section of 9.
- 9a'. Jordan, kernel of 9.

Specimens grown on island off coast of Spain, furnished by Charles Heath, formerly United States consul at Catania, Sicily.



Levytype Co., Engravers and Printers, Phila.

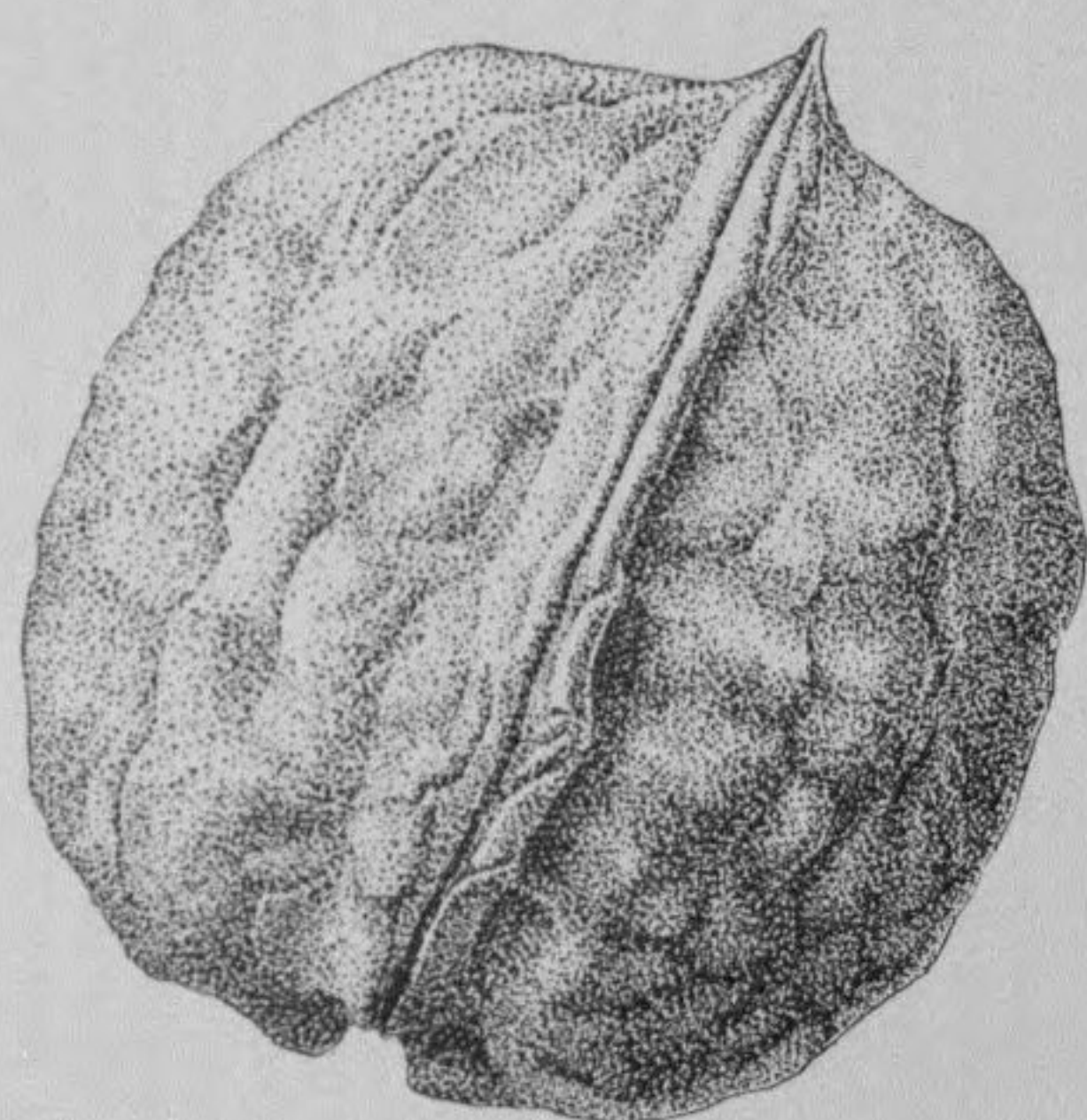
ALMOND.
(*Amygdalus communis*, Linn.)

PLATE 5.

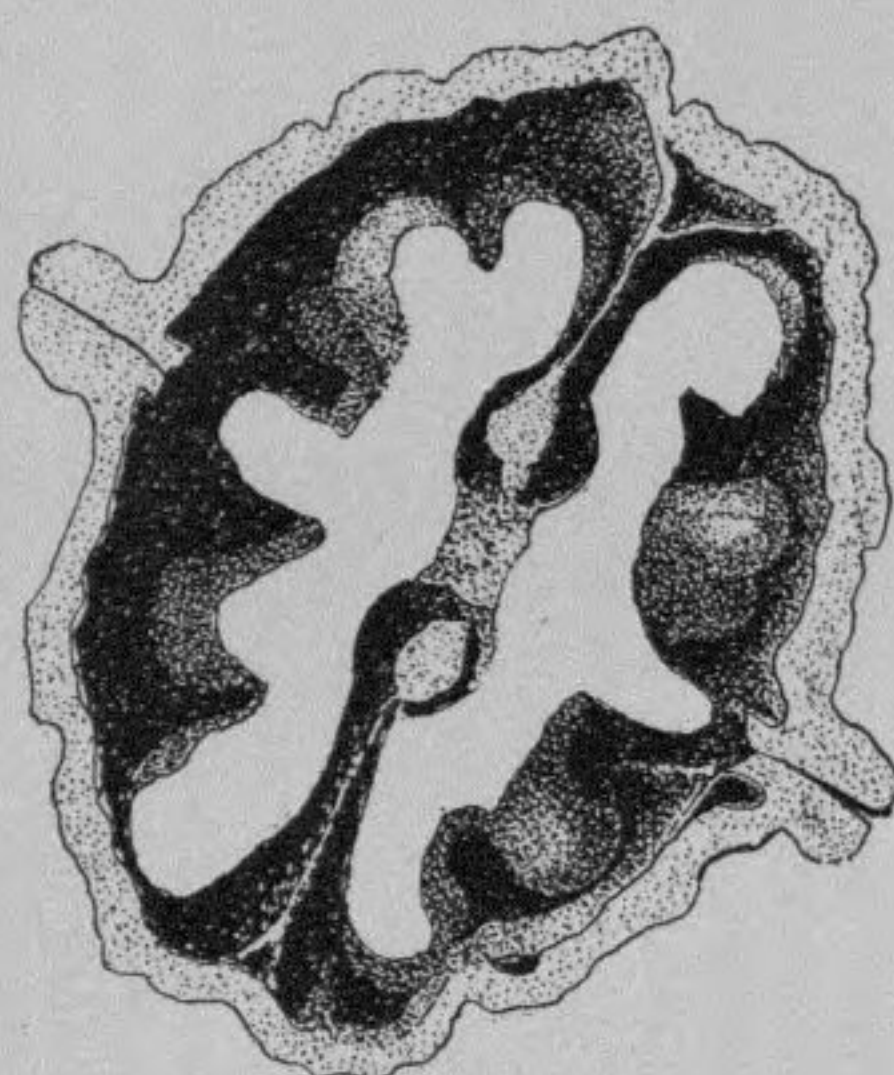
PERSIAN WALNUT.

(*Juglans regia* L.)

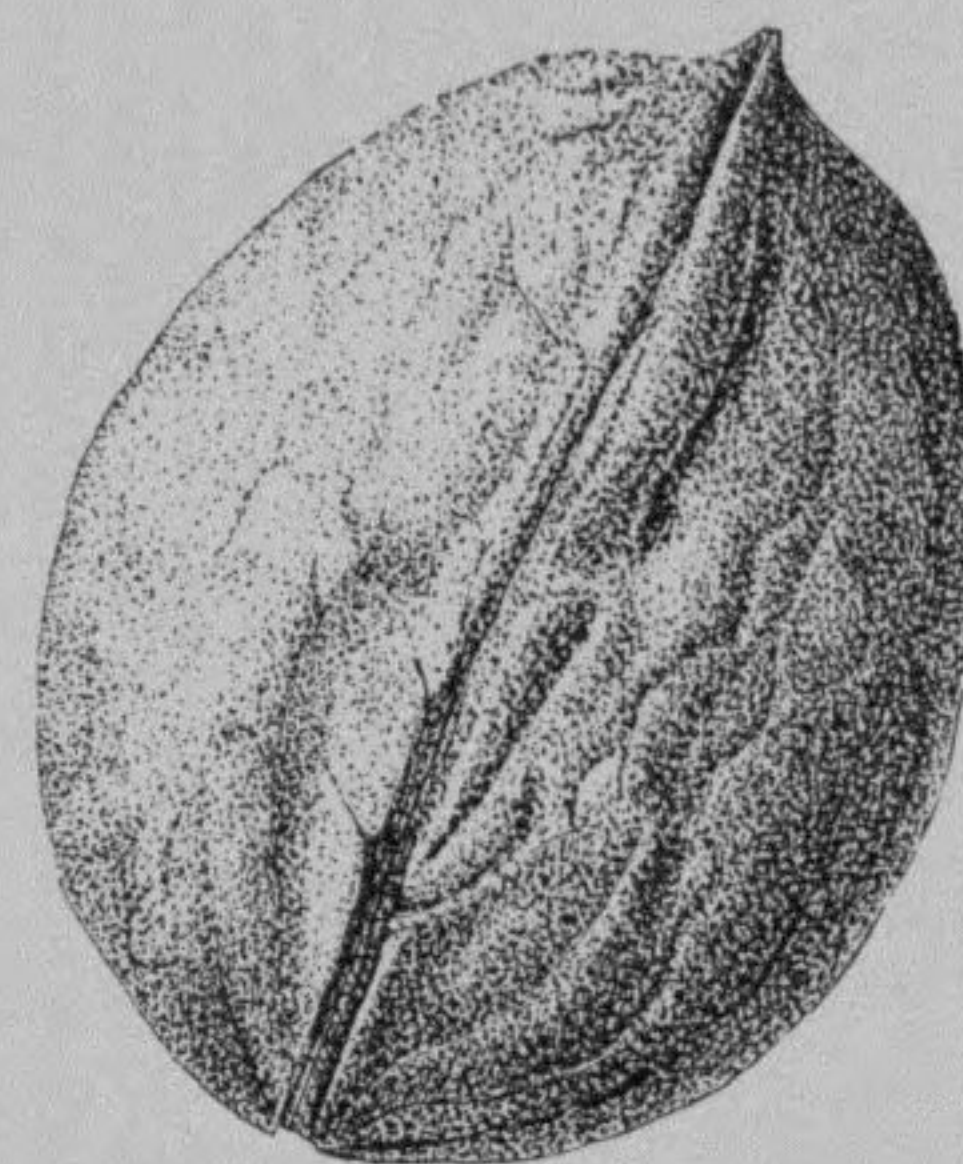
1. Mission. Synonym: *Los Angeles*.
 - 1a. Mission, section of 1. Specimen received from Samuel C. Hammer, Downey, Cal.; grown by H. L. Montgomery, Los Angeles County, Cal.
 2. Præparturiens.
 - 2a. Præparturiens, section of 2. Specimen received from L. L. Bequette, Rivera, Cal.
 3. Mayette.
 - 3a. Mayette, section of 3.
 4. Franquette.
 - 4a. Franquette, section of 4.
 5. Chaberte.
 - 5a. Chaberte, section of 5.
- Specimens of 3, 4, and 5 received from Felix Gillet, Nevada City, Cal. He states that the specimens were grown on grafted trees.



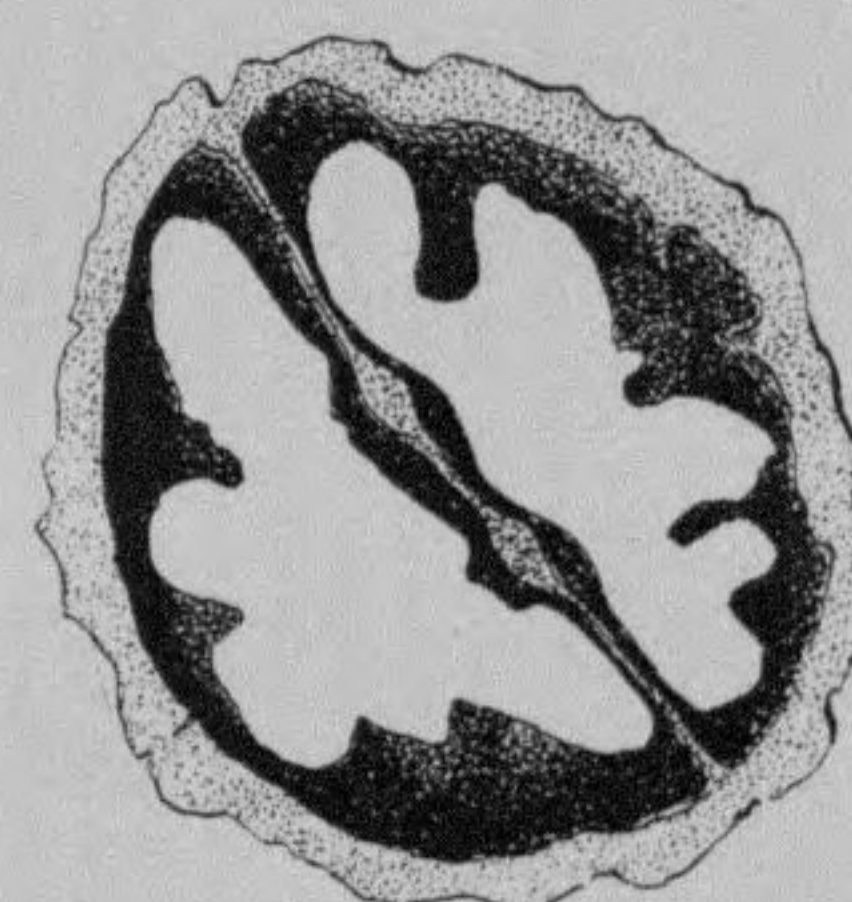
1



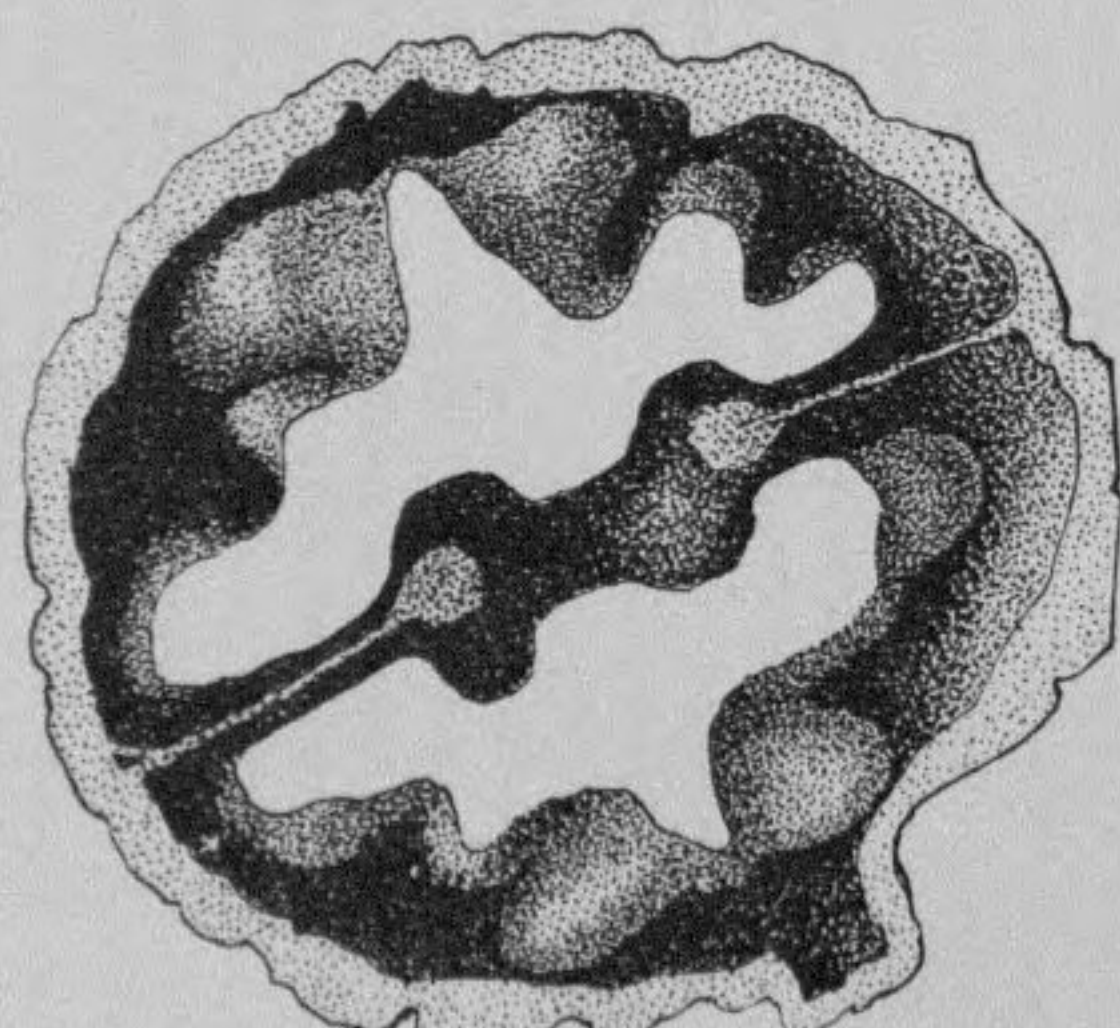
1 α



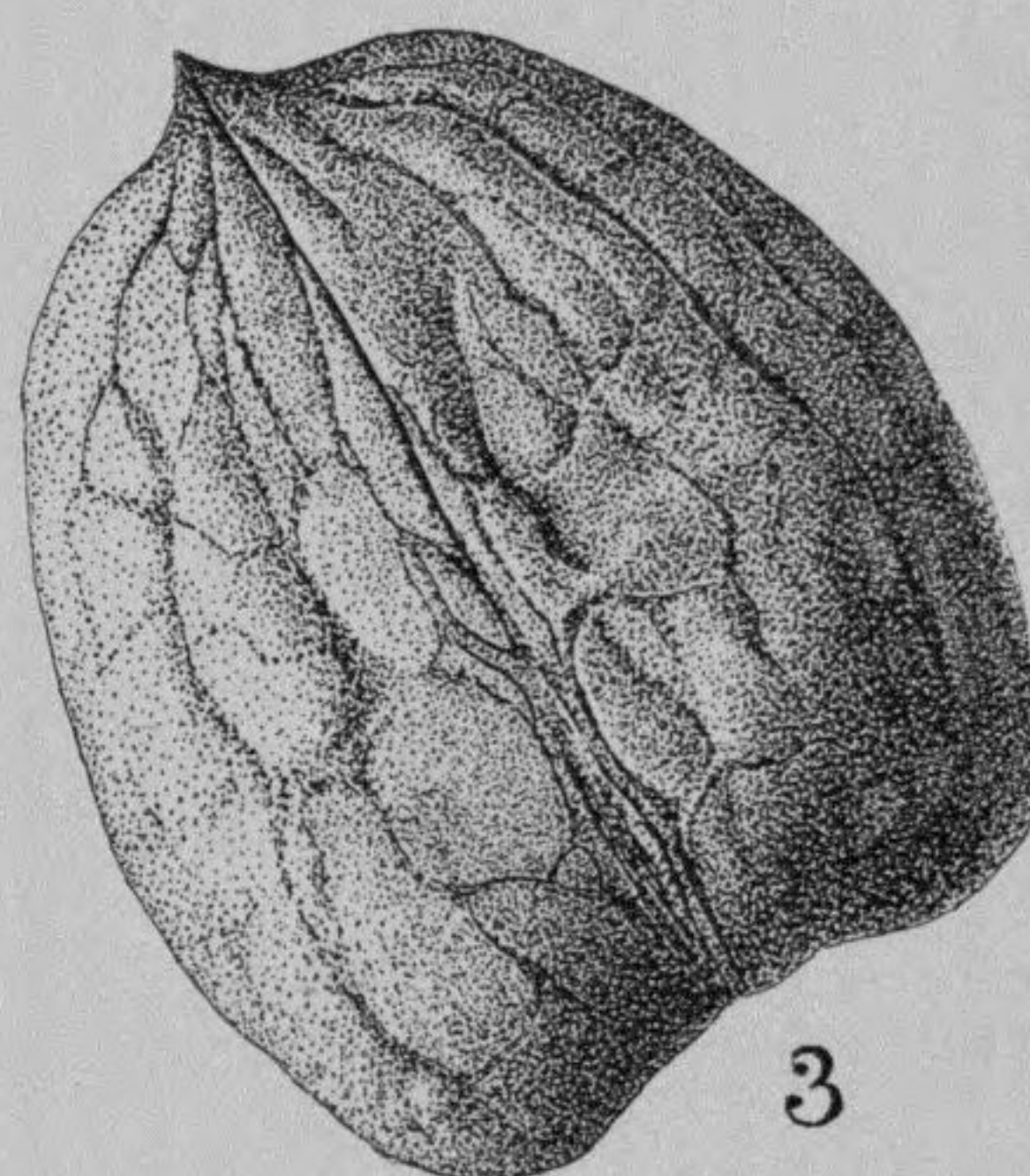
2



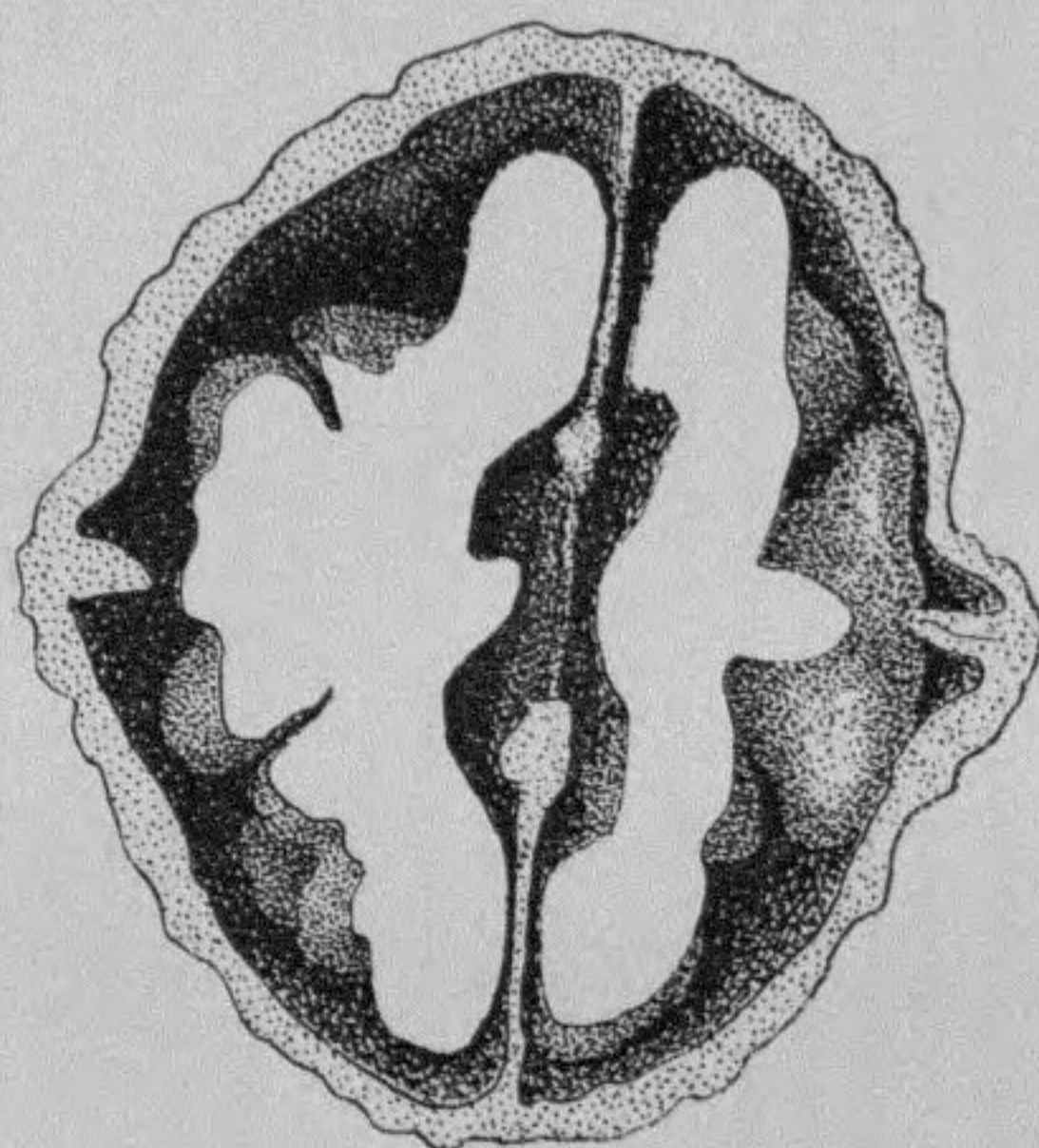
2 α



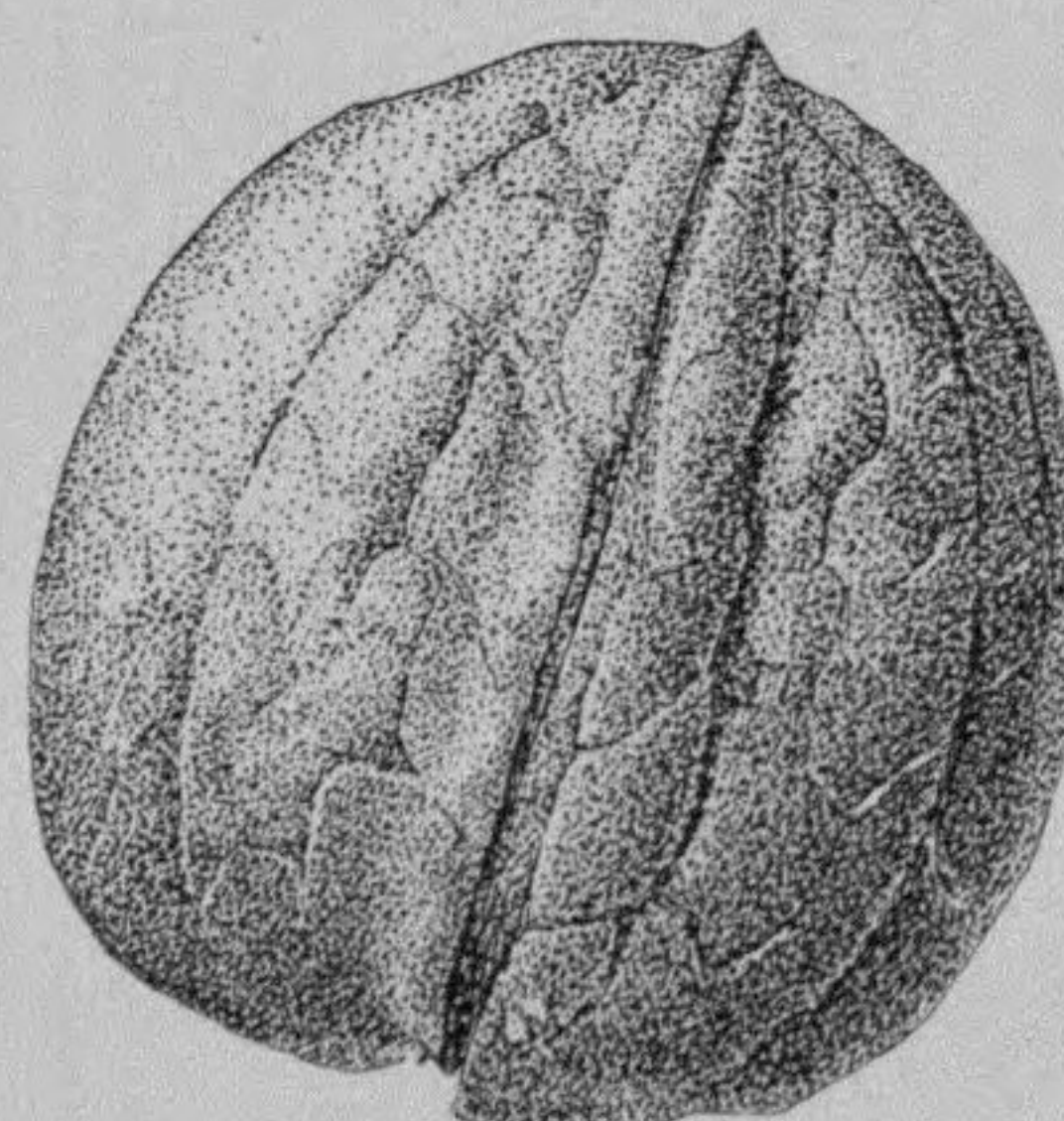
3 α



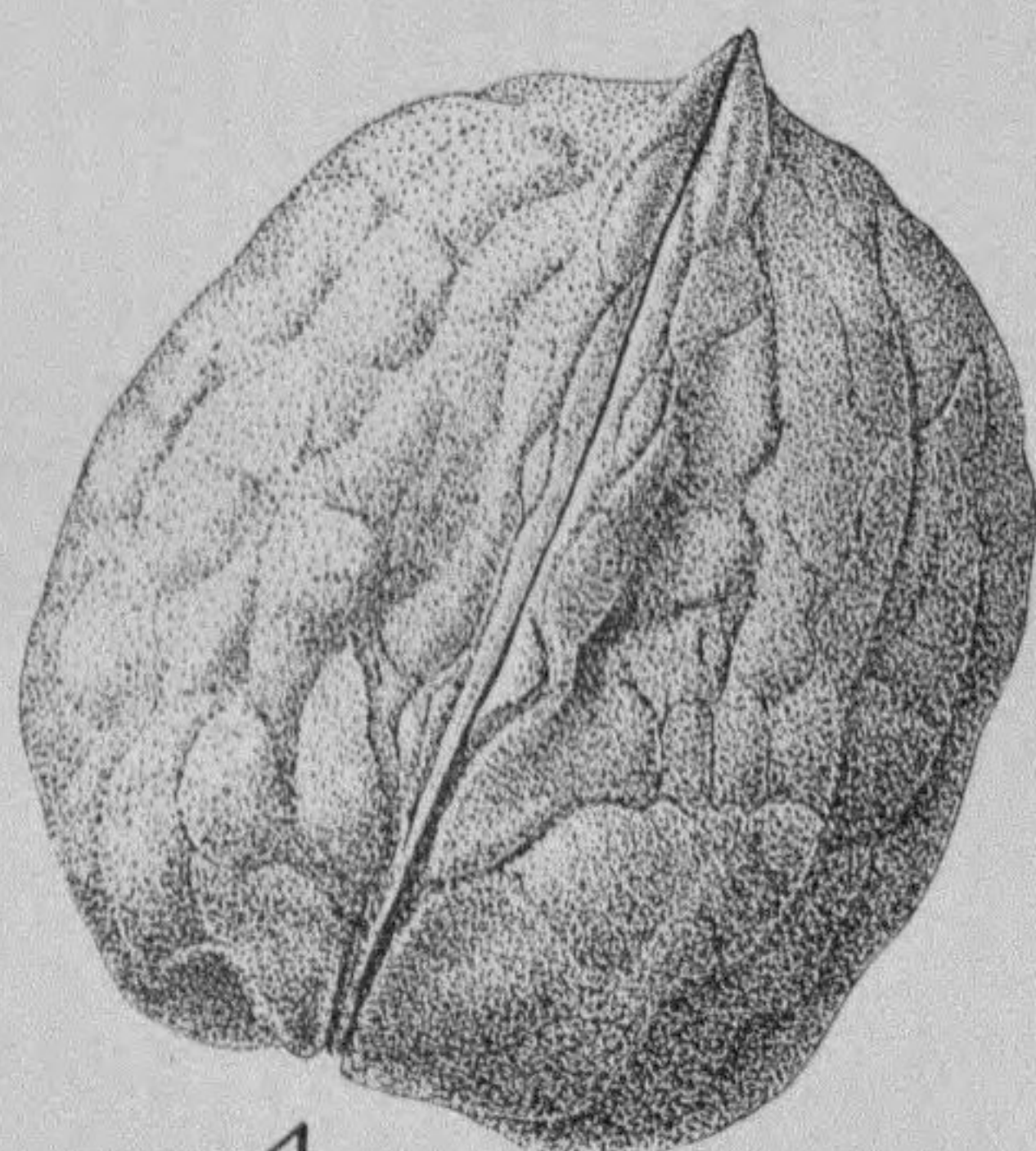
3



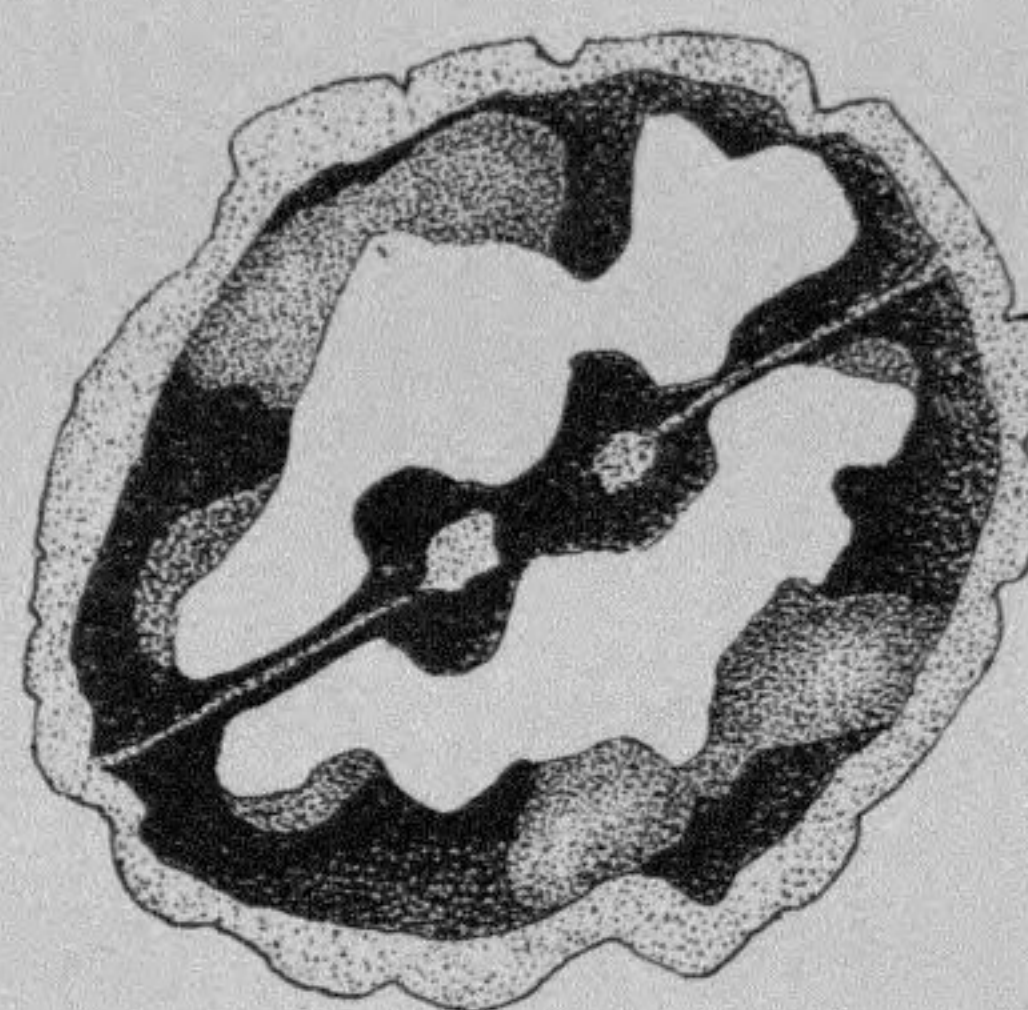
4 α



5



4



5 α

K Mayo del

Levytype Co., Engravers and Printers, Phila.

PERSIAN WALNUT.
(*Juglans regia*, L.)

TABLE 1

Summary of results

1. General results

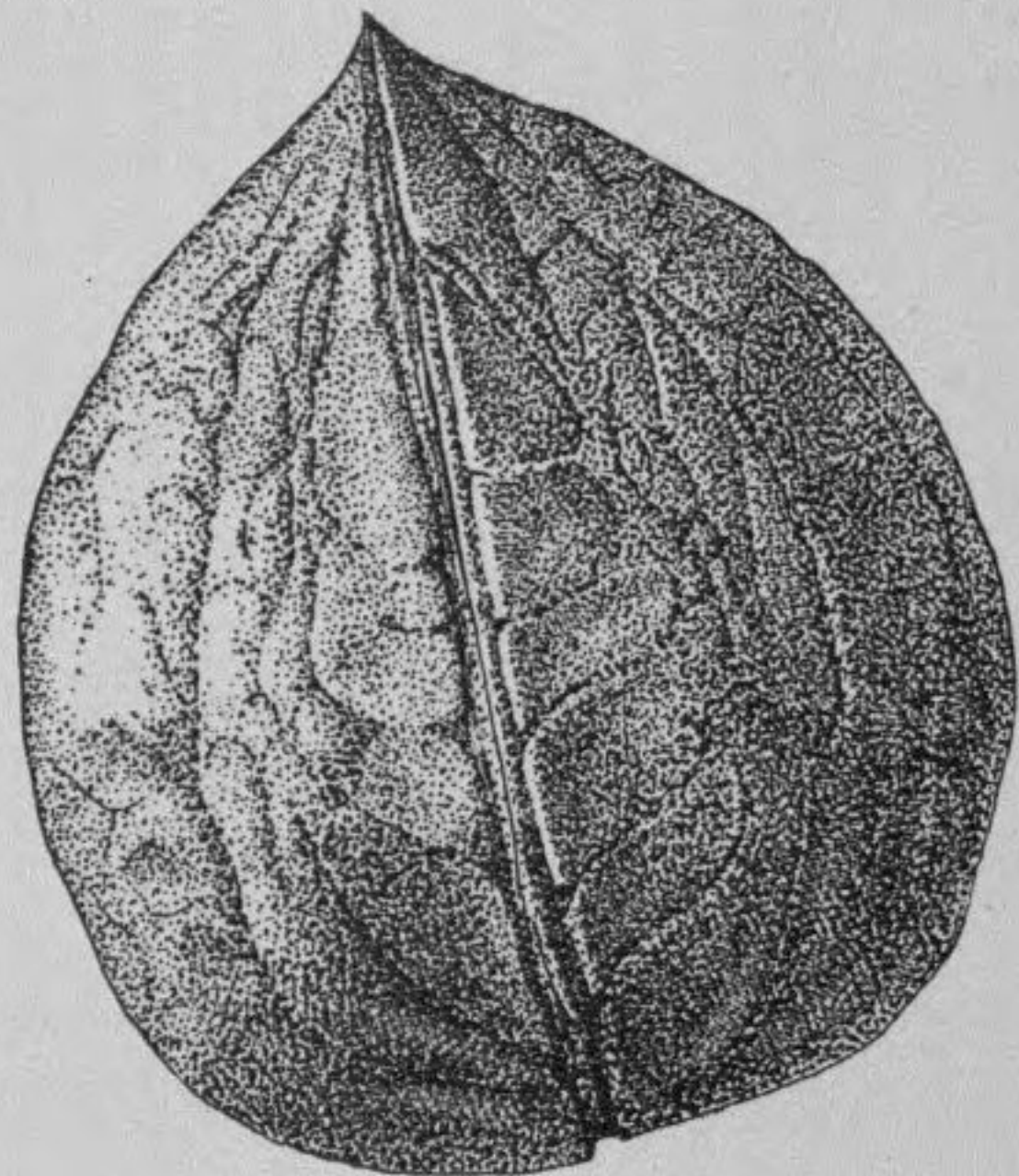
1. The results of the first series of experiments are shown in Table 1.
2. The results of the second series of experiments are shown in Table 2.
3. The results of the third series of experiments are shown in Table 3.
4. The results of the fourth series of experiments are shown in Table 4.
5. The results of the fifth series of experiments are shown in Table 5.
6. The results of the sixth series of experiments are shown in Table 6.
7. The results of the seventh series of experiments are shown in Table 7.
8. The results of the eighth series of experiments are shown in Table 8.
9. The results of the ninth series of experiments are shown in Table 9.
10. The results of the tenth series of experiments are shown in Table 10.

PLATE 6.

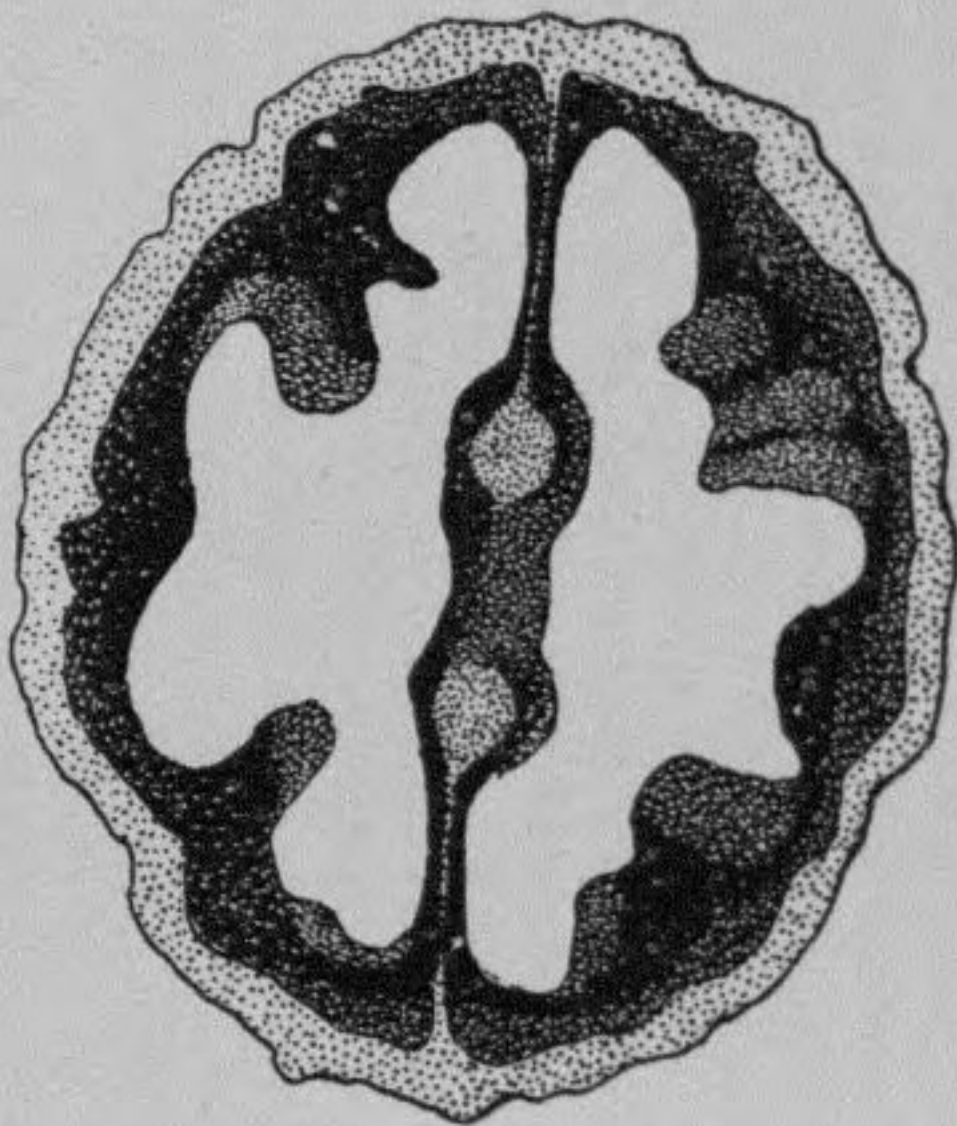
PERSIAN WALNUT.

(*Juglans regia* L.)

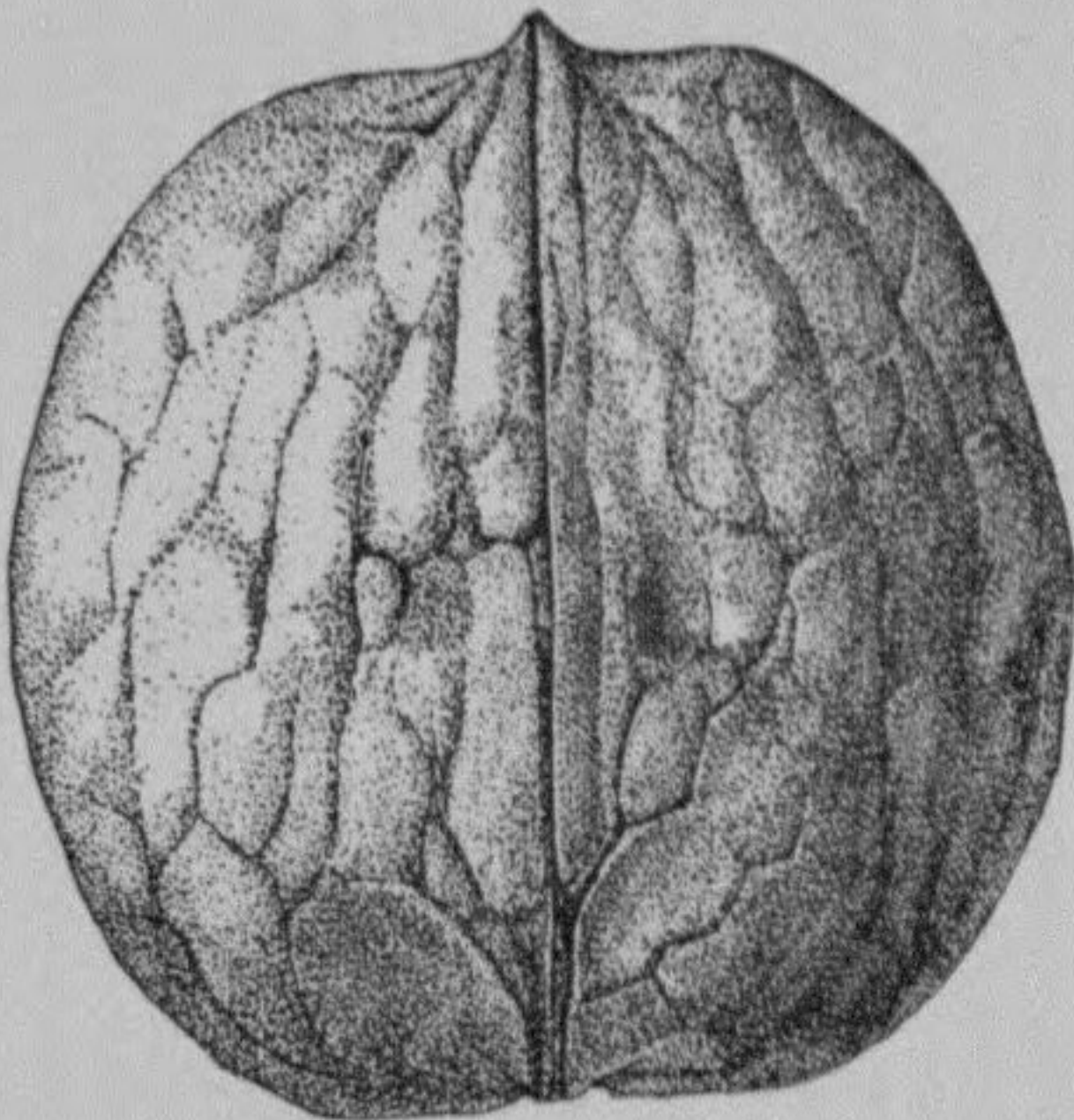
1. Cluster.
- 1a. Cluster, section of 1. Specimens from Felix Gillet, Nevada City, Cal.
2. Grand Noblesse.
- 2a. Grand Noblesse, section of 2. Specimen from L. L. Bequette, Rivera, Cal.
3. Ford (softshell).
- 3a. Ford (softshell), section of 3. Specimen from George W. Ford, Santa Ana, Cal.
4. Gant. Syn. *Bijou*.
- 4a. Gant, section of 4. Specimen from Felix Gillet, Nevada City, Cal.



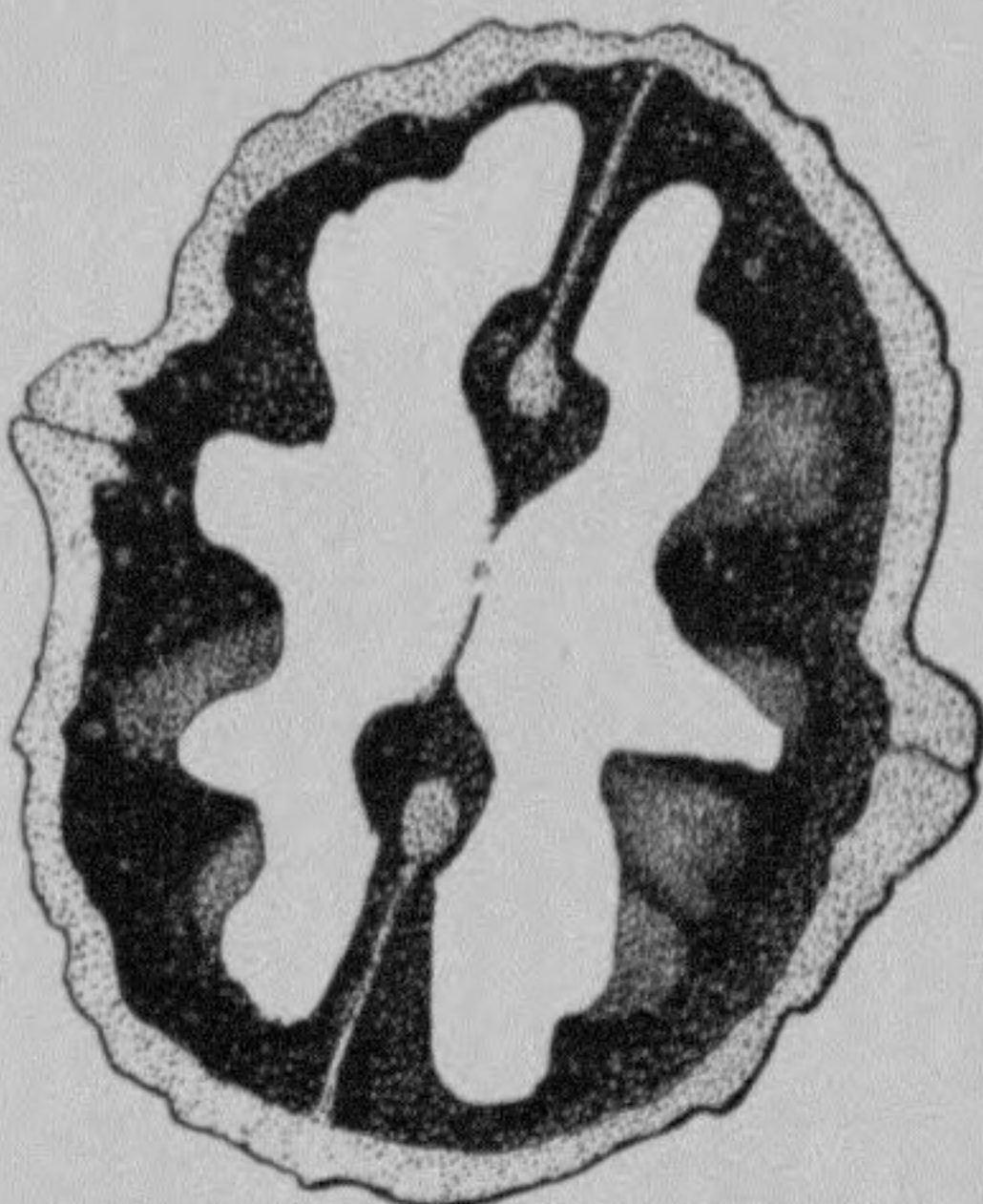
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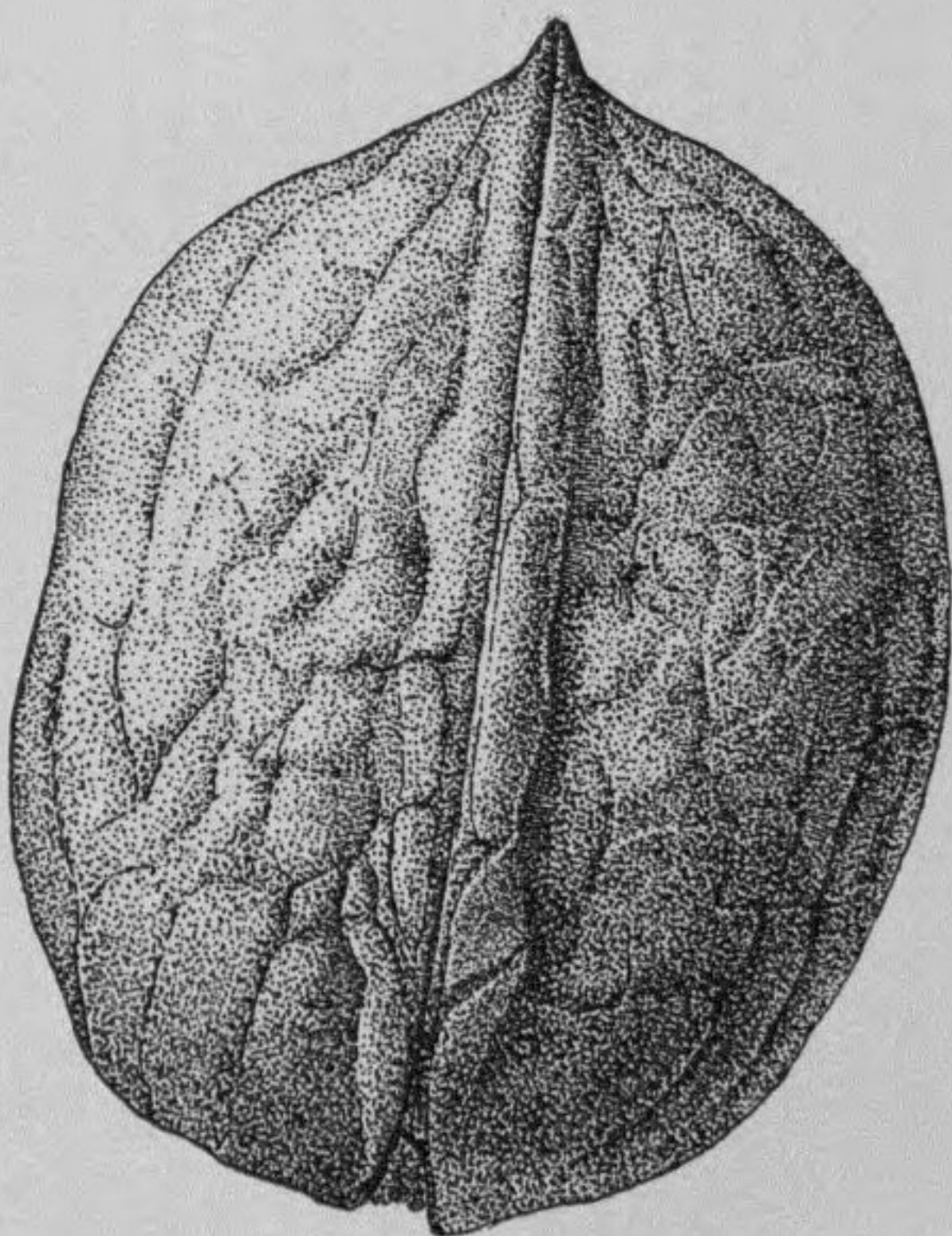
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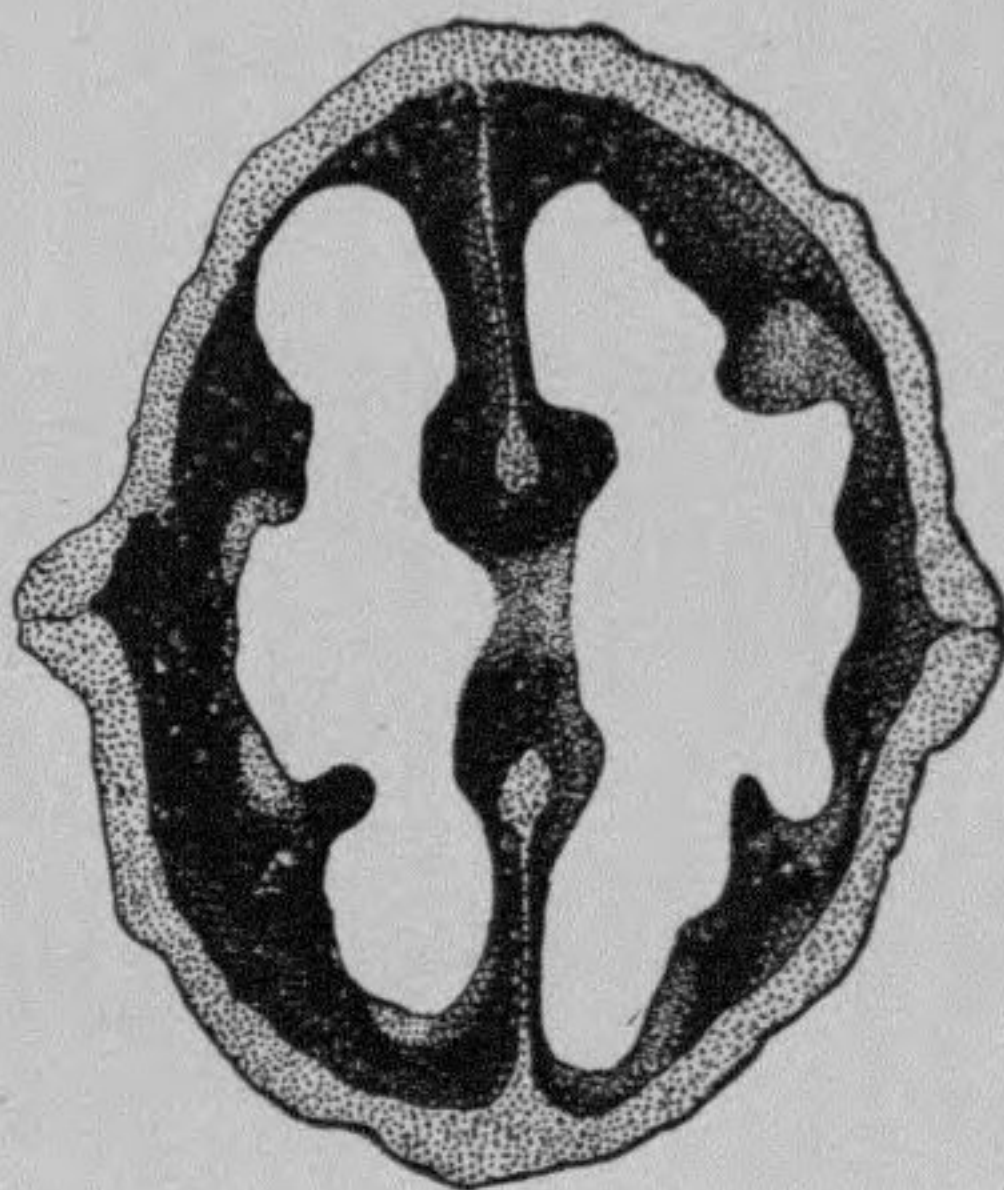
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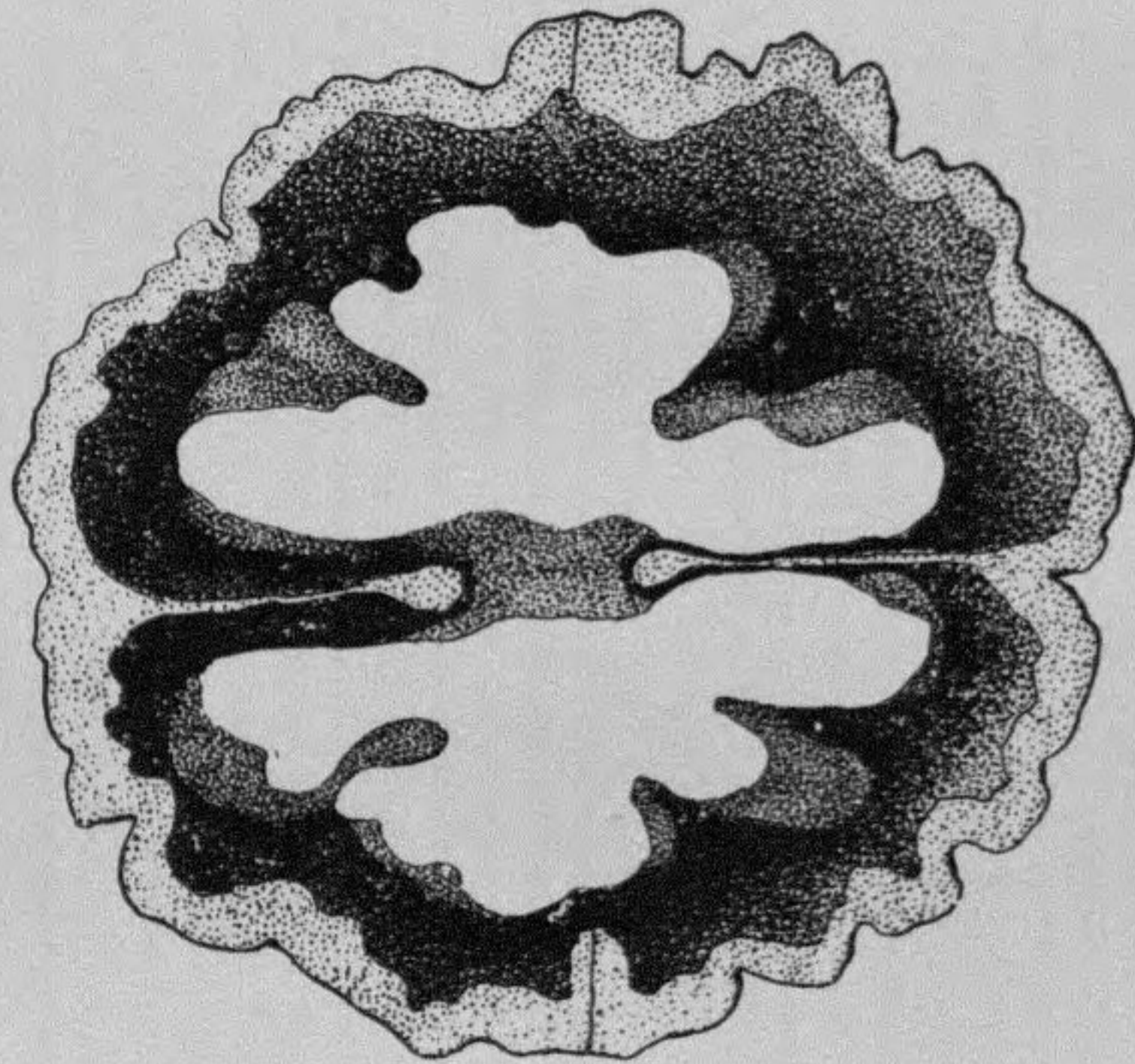
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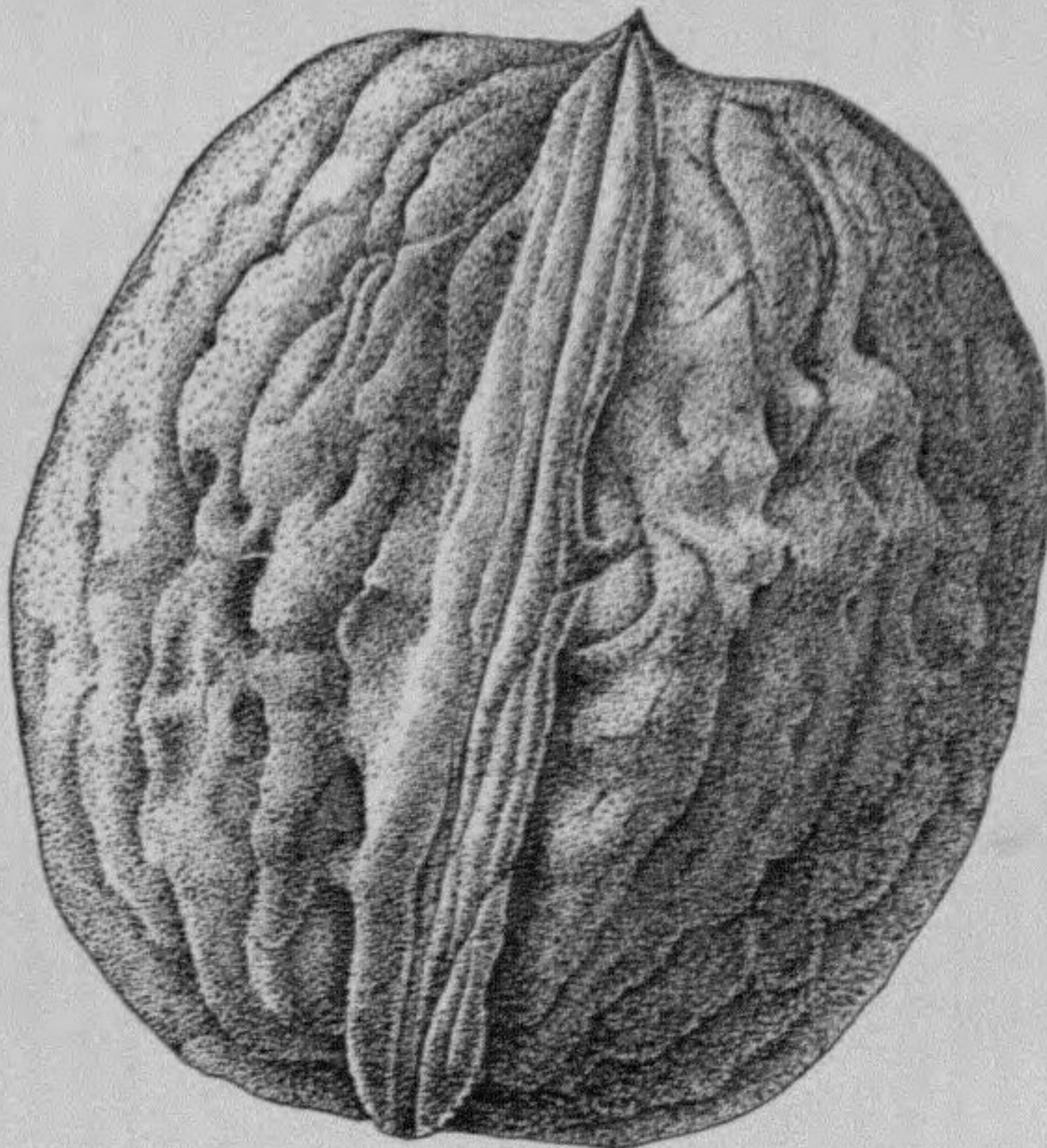
3



3 α



4 α



4

K Mayo del.

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PERSIAN WALNUT.
(*Juglans regia*, L.)

PLATE 7.

MISCELLANEOUS WALNUTS.

Black walnut. (*Juglans nigra* L.)

1. Taylor.

1a. Taylor, section of 1.

2. "Peanut."

Specimens of 1 and 2 from W. N. Irwin, South Salem, Ohio.

3. Mirza.

3a. Mirza, section of 3. Specimen from W. H. McKinney, Morrow, Ohio.

Butternut. (*Juglans cinerea* L.)

4. Specimen from S. B. Cole, Bridgeton, N. J.

Japanese walnuts.

5. *Juglans mandshurica* Maxim.

5a. *Juglans mandshurica*, section of 5.

6. *Juglans cordiformis* Maxim.

7. *Juglans sieboldiana* Maxim.

7a. *Juglans sieboldiana*, section of 7.

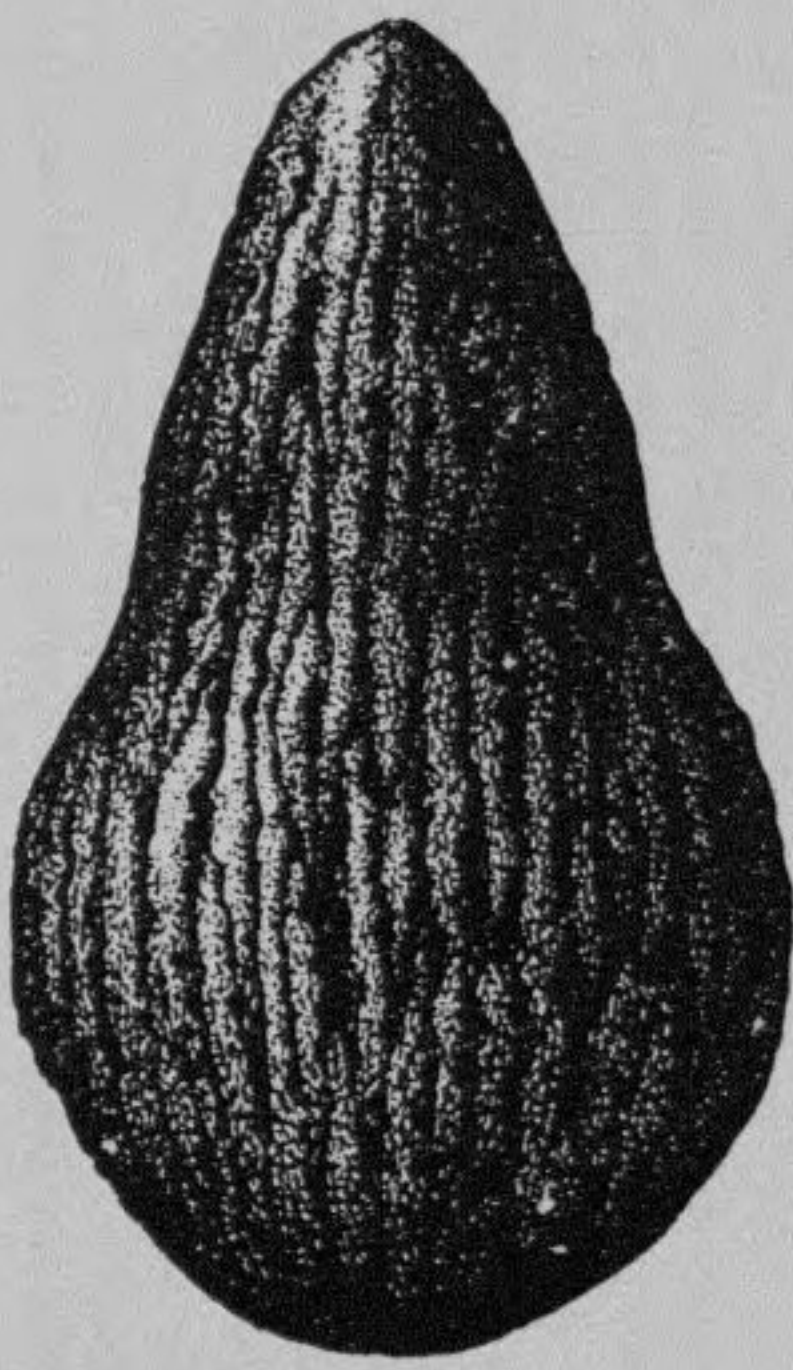
Specimens of 5, 6, and 7 from Luther Burbank, Santa Rosa, Cal.

Hybrid walnut.

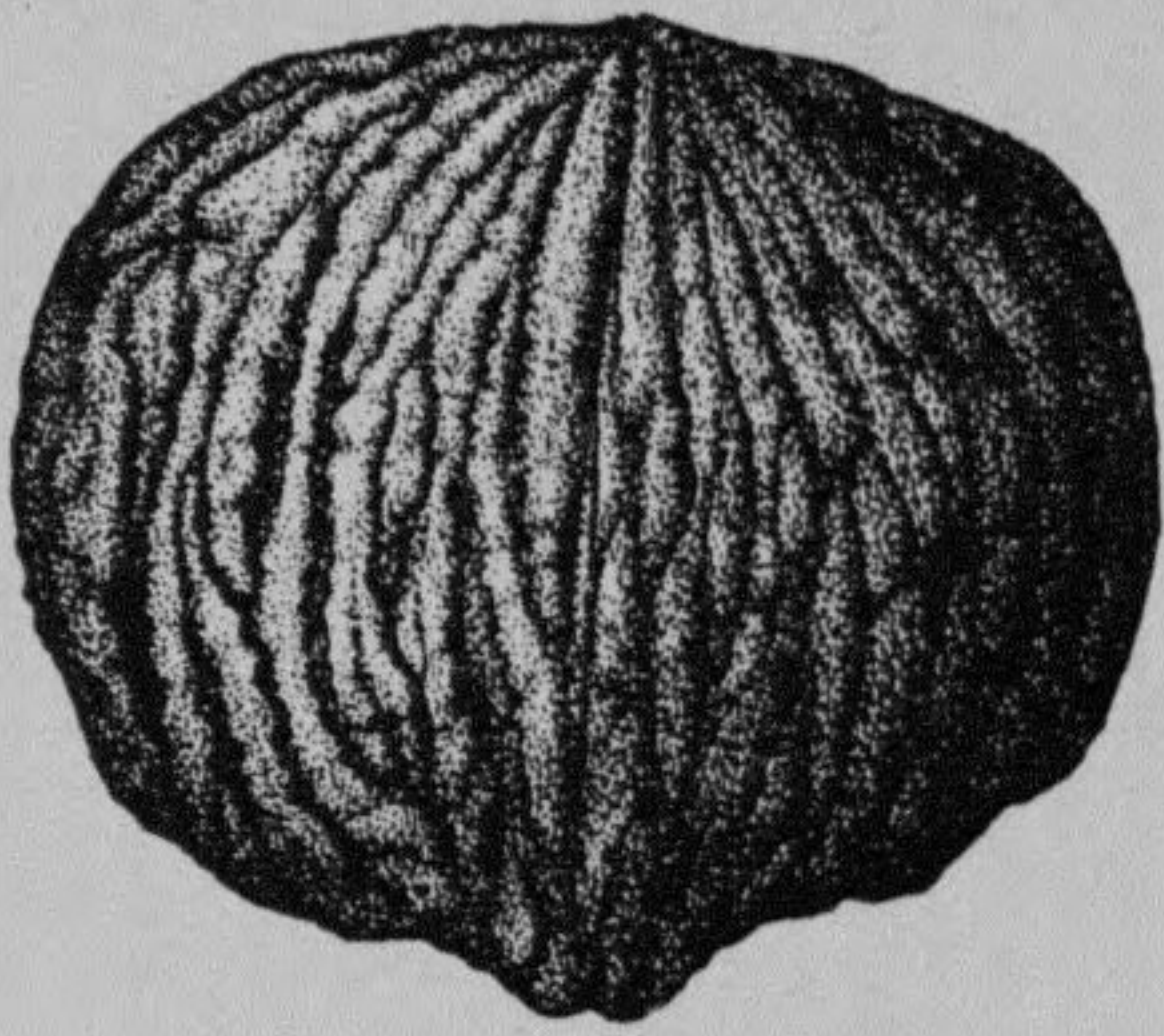
8. Vilmorin. Specimen from Felix Gillet, Nevada City, Cal.



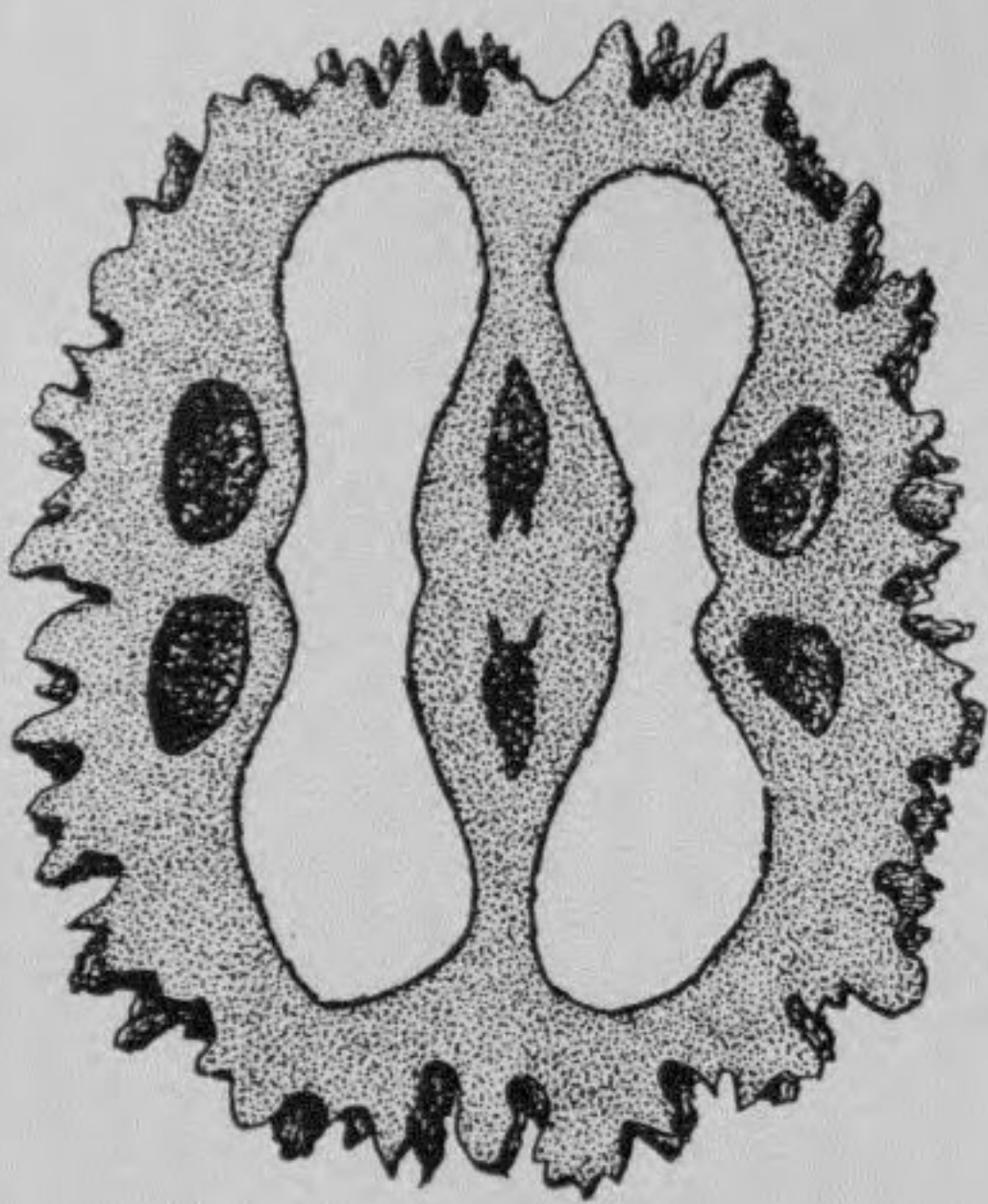
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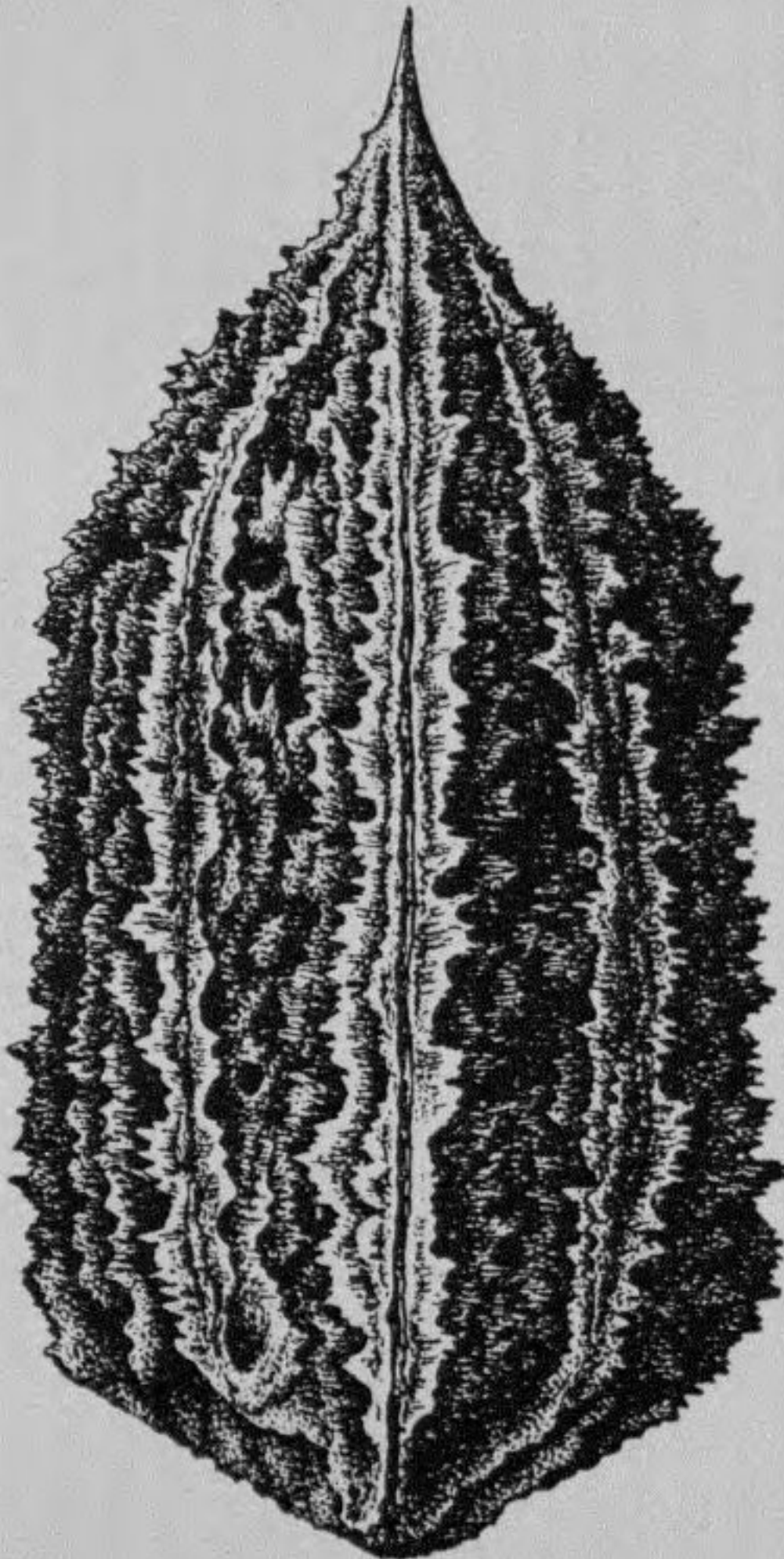
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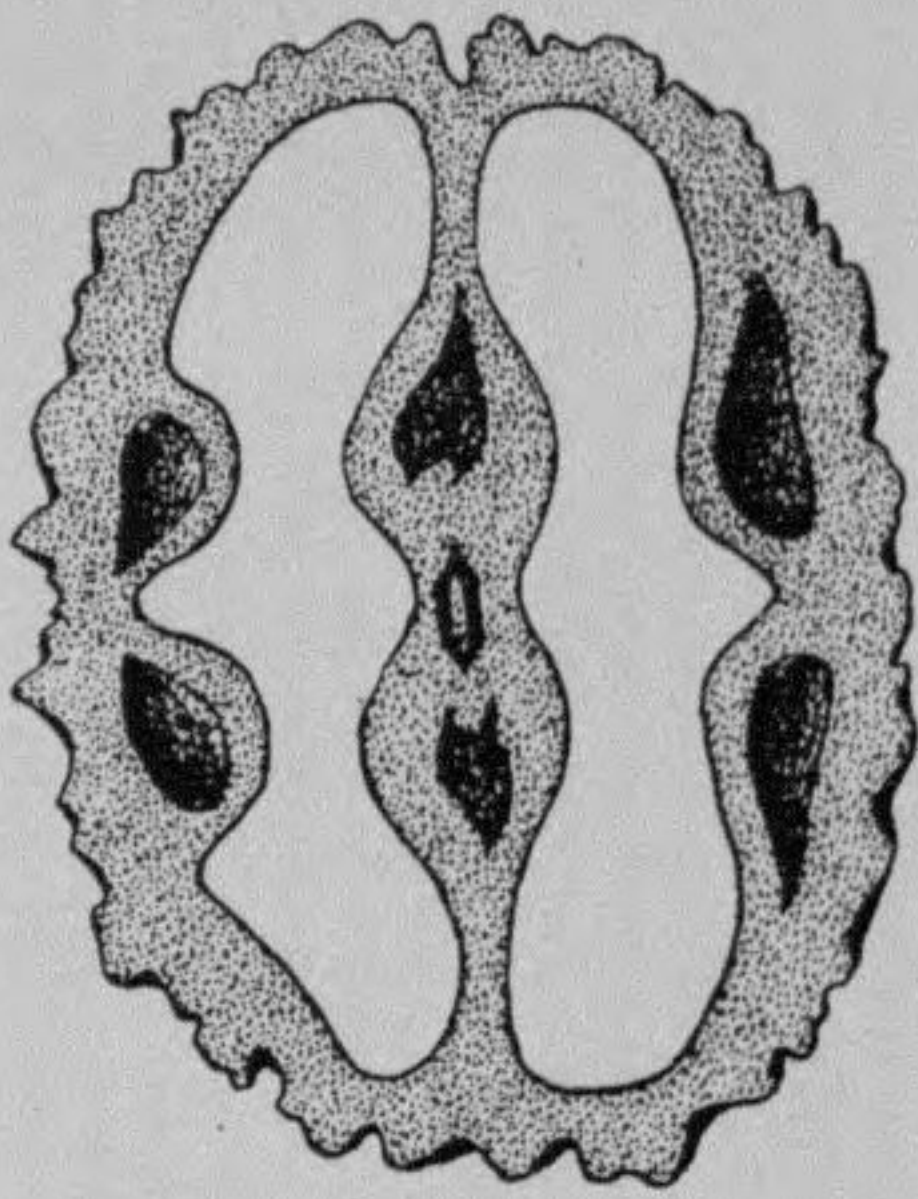
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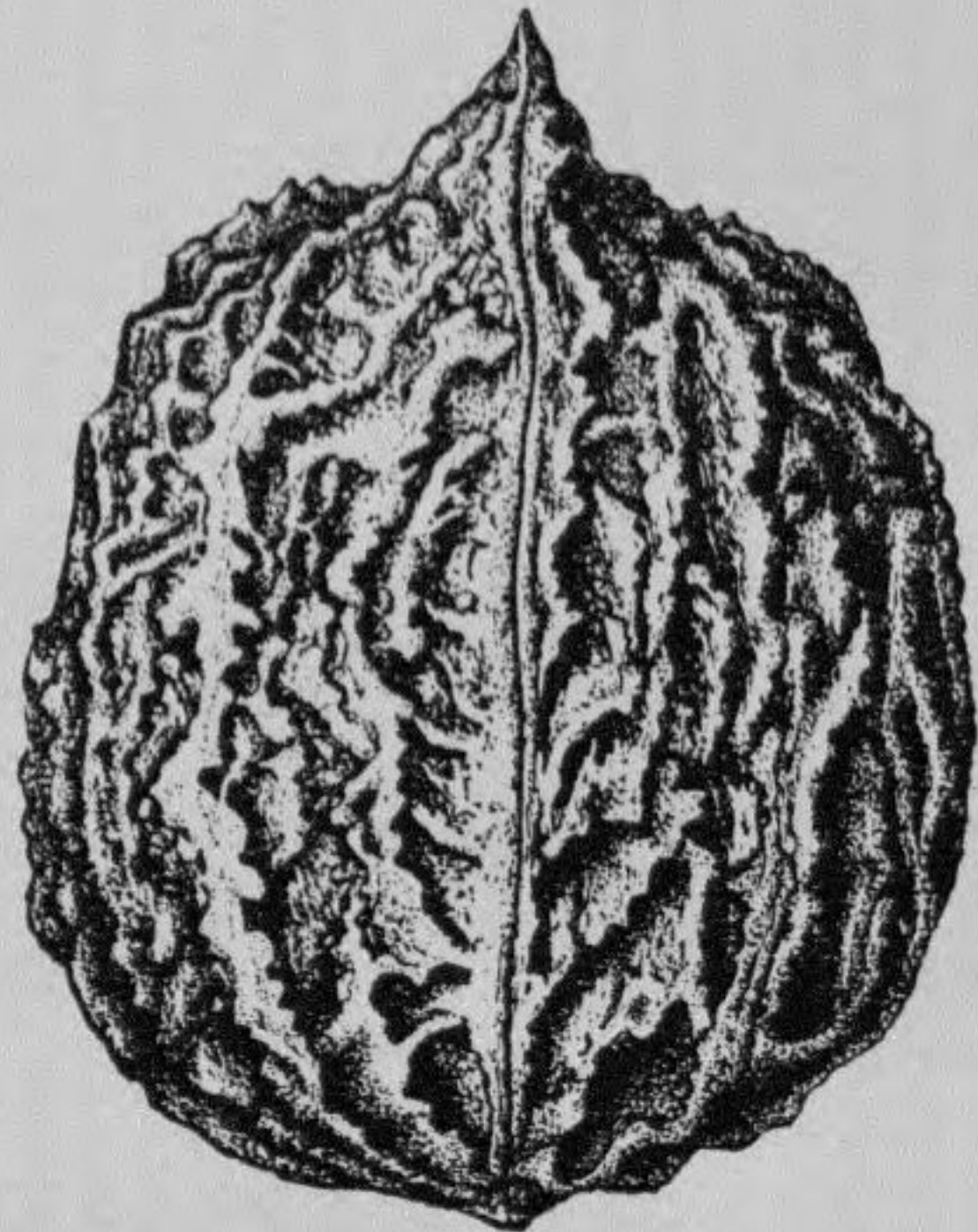
1α



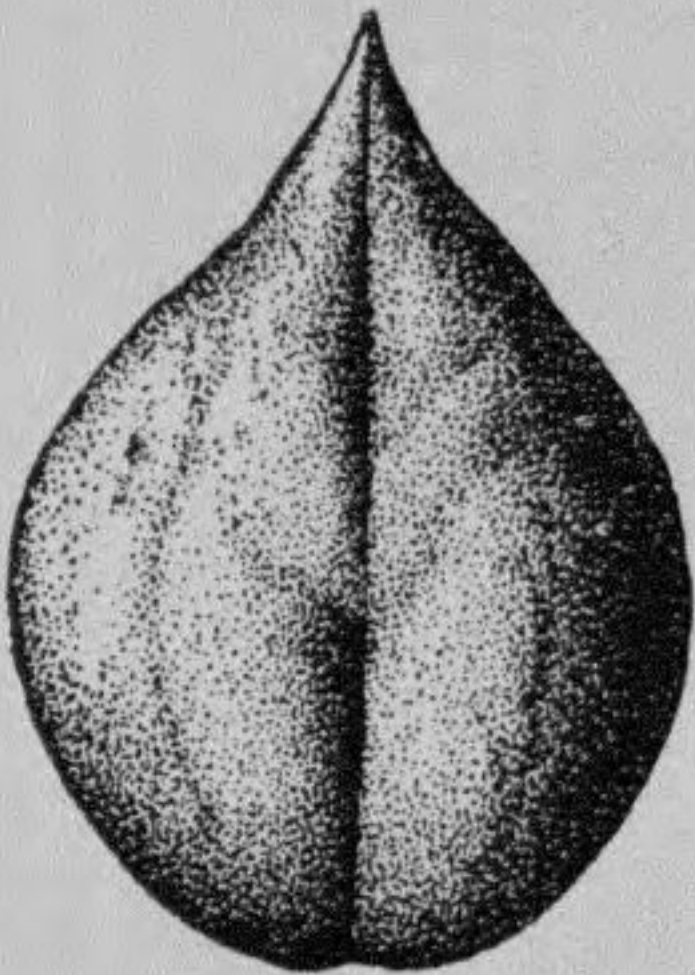
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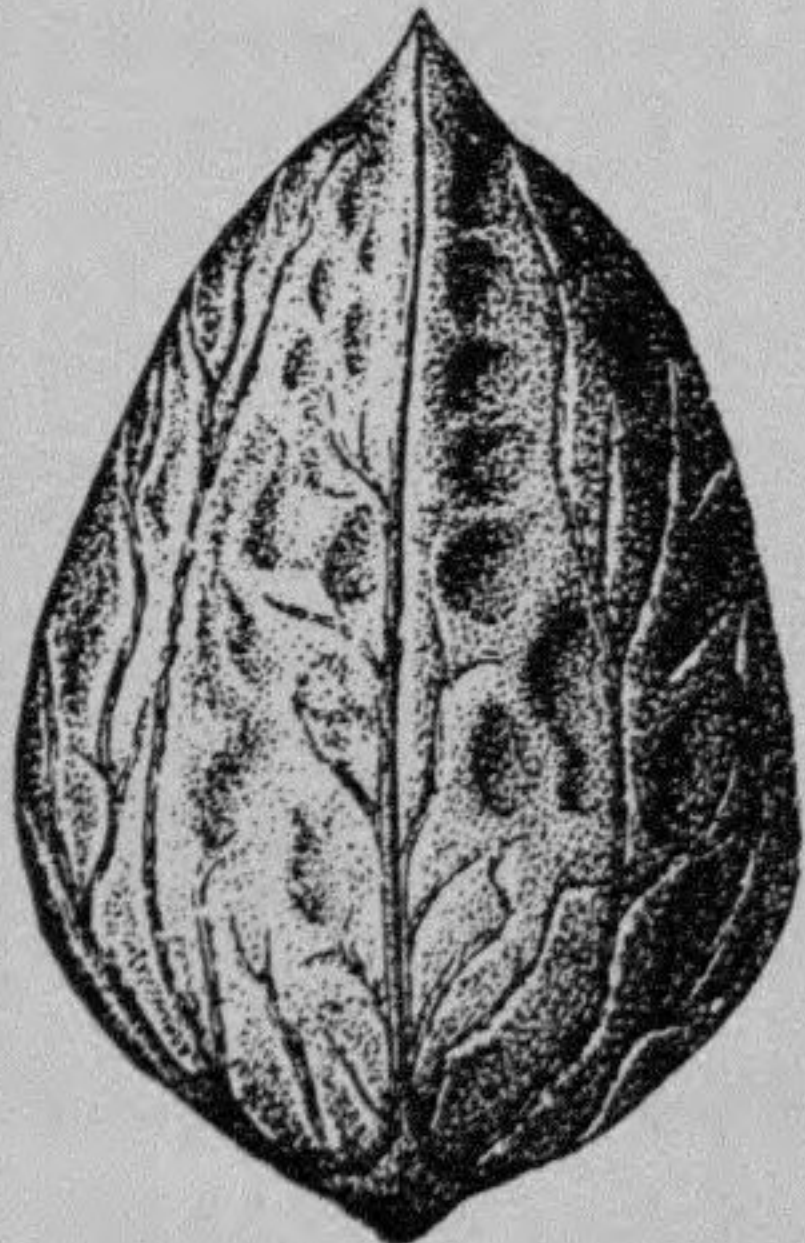
3α



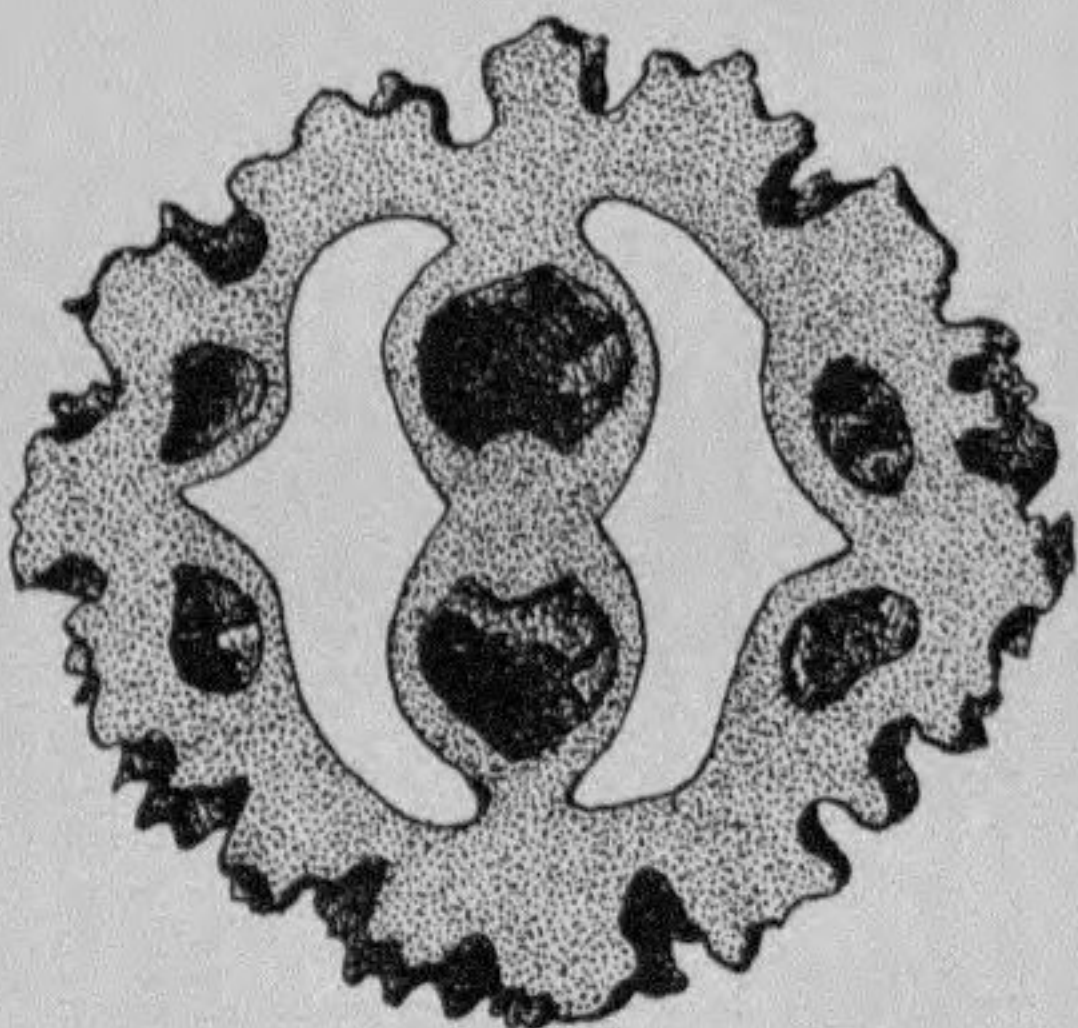
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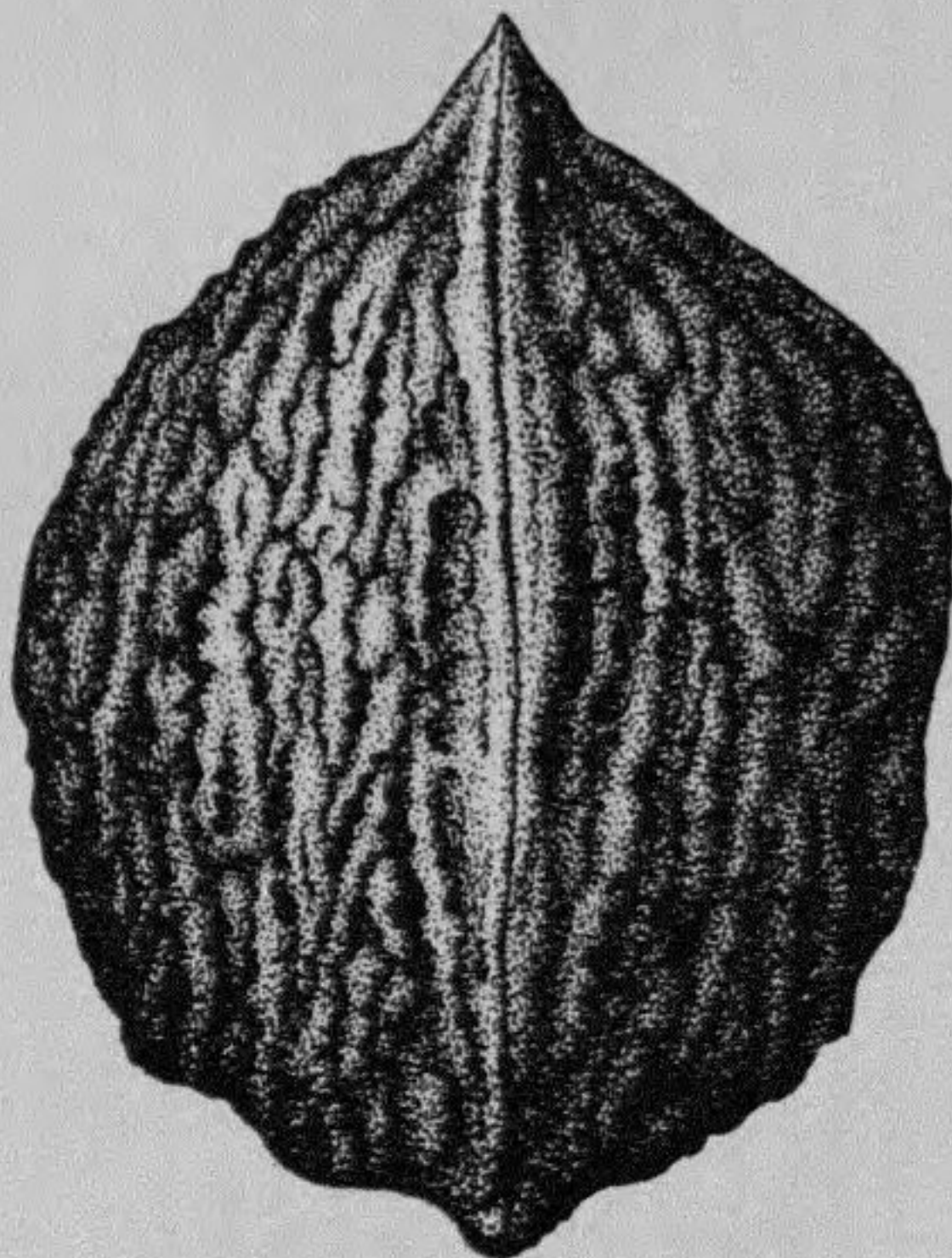
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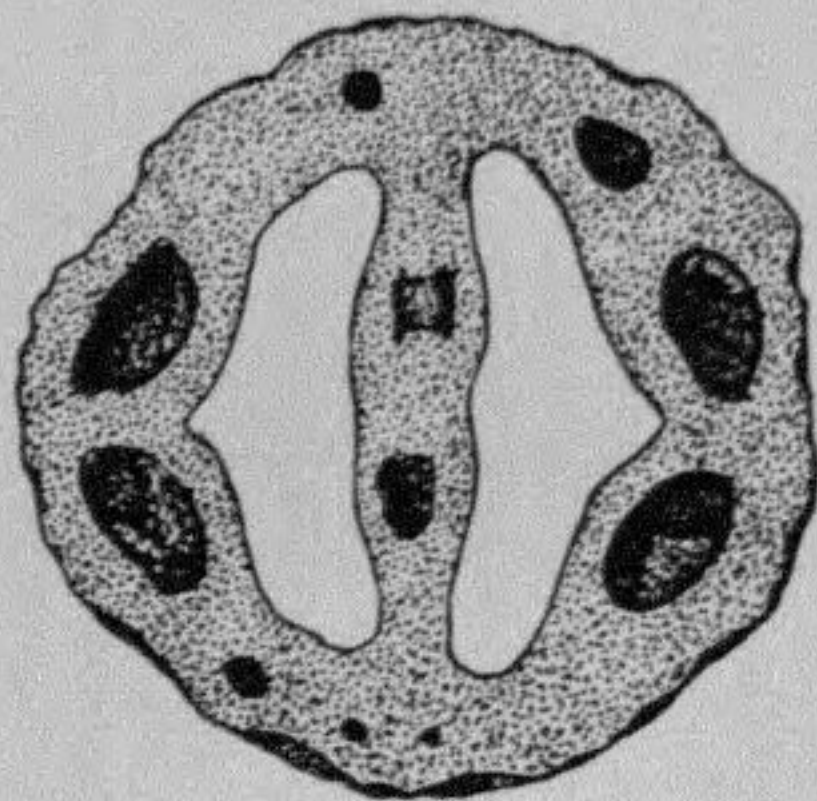
7



5α



8



7α

D. Oleszewski del.

1912

1913

(1) and (2) are the same as in the previous year.

1914

1915

1916

1917

1918

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1920

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1960

PLATE 8.

PECAN.

(*Hicoria pecan* Britton. Synonym: *Carya olivæformis* Nuttall.)

Variation in form of wild nuts:

1. Round conical.
2. Roundish truncate.
3. Olive-shaped.
4. Long conical.
5. Globular.
6. Elongated.

Varying characteristics in dehiscence:

7. Nut-retaining.
8. Nut-releasing.
9. Thick hulled.

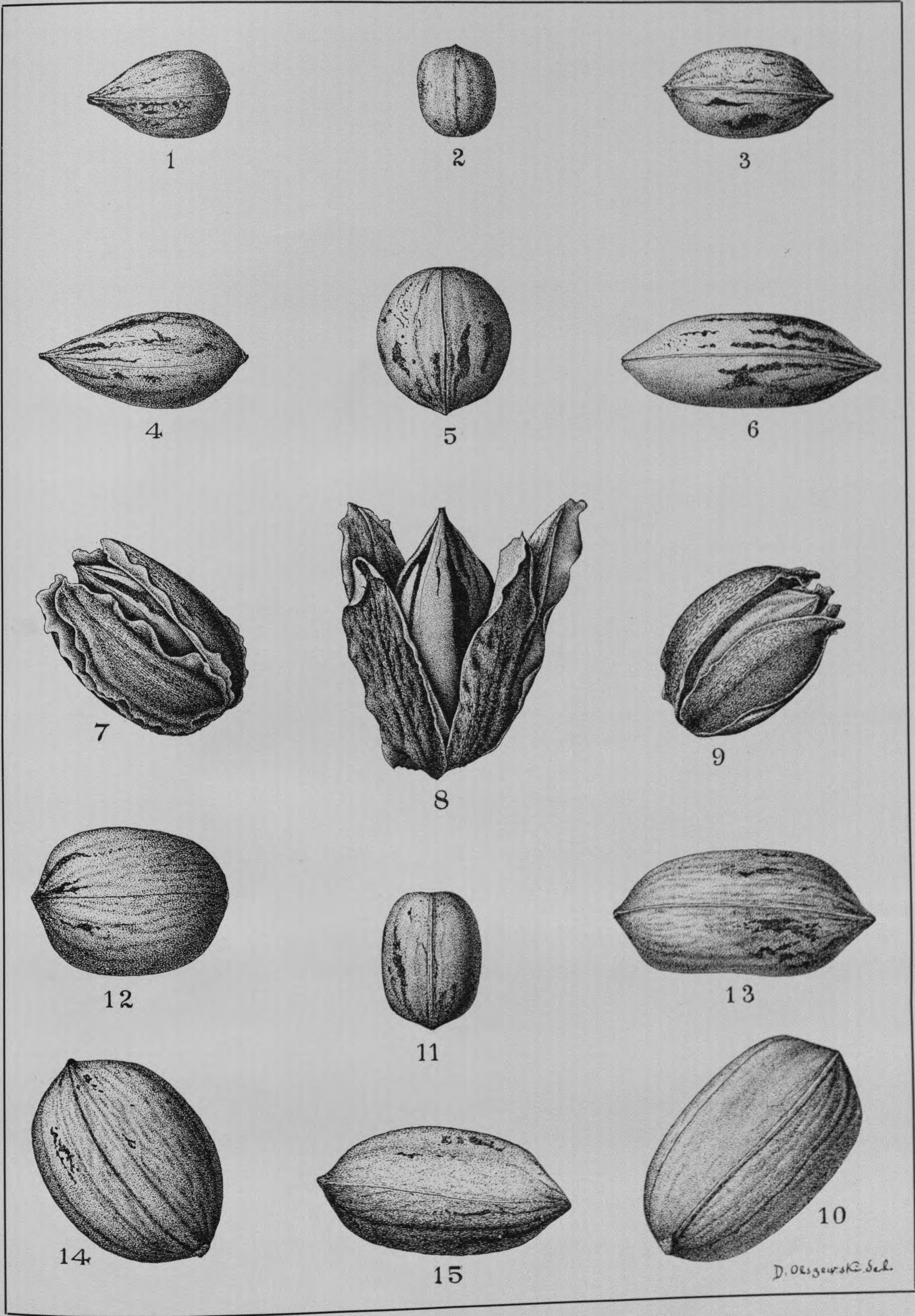
Deterioration of seedlings:

10. A large nut from San Saba, Tex.
11. A seedling of No. 10.

Specimens of 10 and 11 were furnished by Felix Gillet, Nevada City, Cal., who states that he received them from E. E. Risien, San Saba, Tex.

Named varieties:

12. Post. Specimen from Herbert Post, Fort Worth, Tex.
13. Biloxi. Specimen from the late W. R. Stuart, Ocean Springs, Miss.
14. Risien. Specimen from E. E. Risien, San Saba, Tex.
15. ———. Specimen from B. M. Young, Morgan City, La.



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PECAN.

(*Hicoria pecan*, Britton.)
(Syn. *Carya olivæformis*, Nutt.)

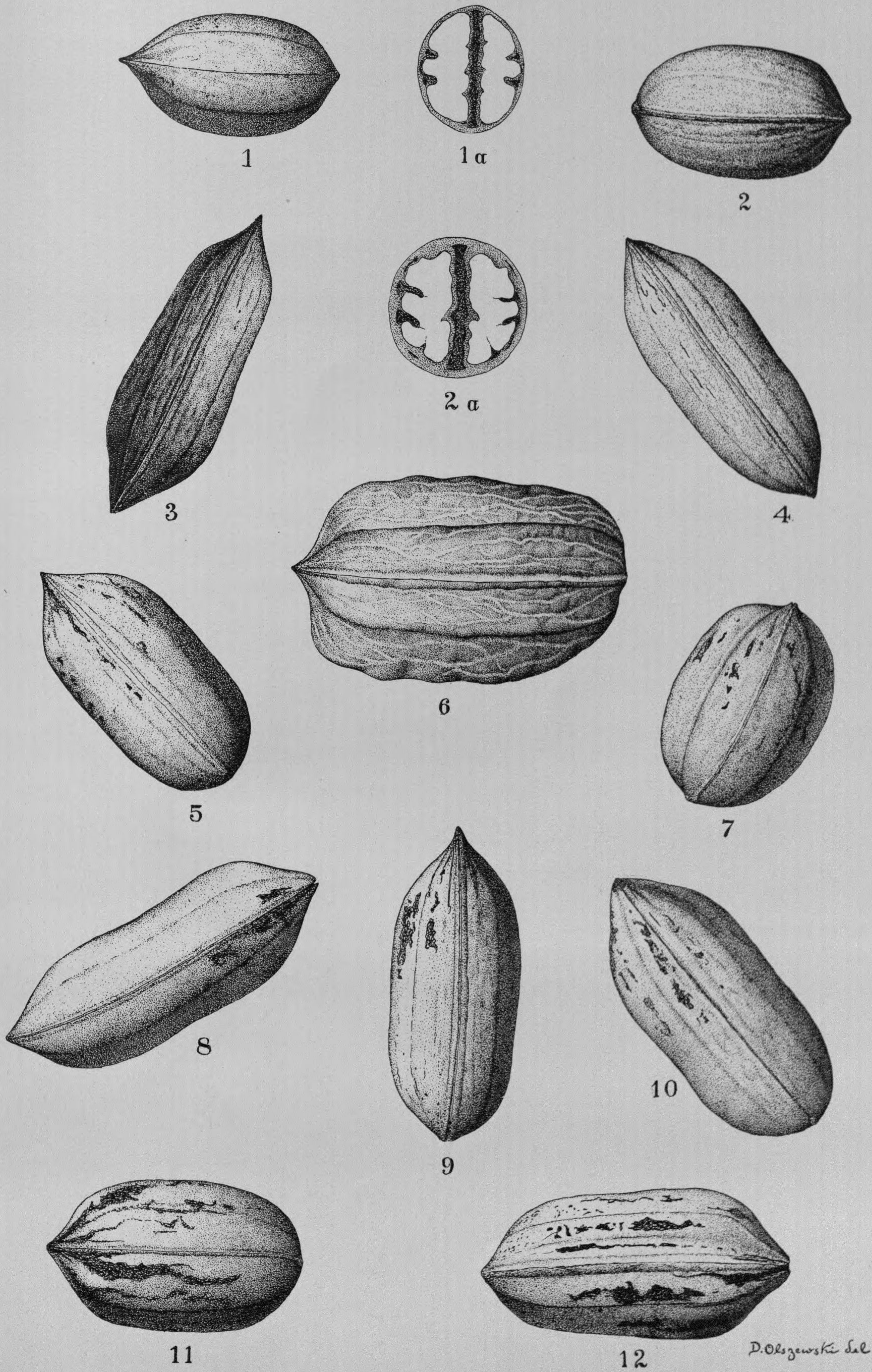
PLATE 9.

PECAN.

(*Hicoria pecan* Britton. Synonym: *Carya olivæformis* Nuttall.)

Named varieties:

1. Pearl.
- 1a. Pearl, section of 1. Specimen from T. V. Munson, Denison, Tex.; collected by E. E. Risien, San Saba, Tex.
2. Idlewild.
- 2a. Idlewild, section of 2. Specimen from Louis Biediger, Idlewild, Tex.
- 3, 4. Faust. Specimens showing variation in form on same tree, from O. D. Faust, Bamberg, S. C.
5. Frotscher. Specimen from Richard Frotscher, New Orleans, La.
6. McCallister. (Probably a hybrid.) Specimen from O. L. McCallister, Mount Vernon, Ind.
7. Jumbo. Specimen from F. M. Ramsey, Bluffton, Tex.
8. Centennial.
9. Van Deman.
Specimens 8 and 9 from the late W. R. Stuart, Ocean Springs, Miss.
10. Mammoth. Specimen from Richard Frotscher, New Orleans, La.
11. Stuart.
12. Jewett.
Specimens 11 and 12 from the late W. R. Stuart, Ocean Springs, Miss.



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PECAN.
(*Hicoria pecan*, Britton.)
(Syn. *Carya olivæformis*, Nutt.)

PLATE 10.

SHAGBARK.

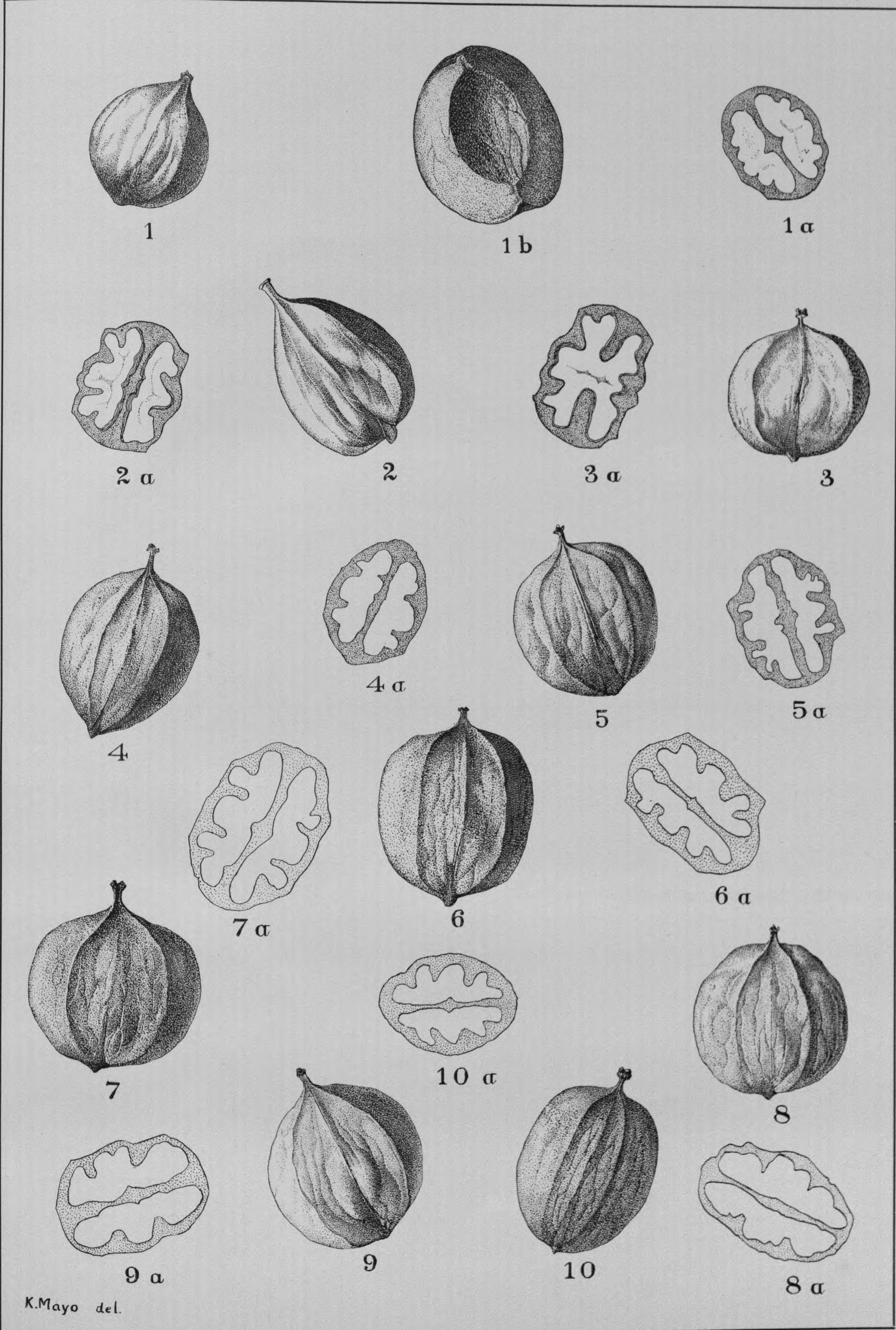
(*Hicoria ovata* Britton. Synonym: *Carya alba* Nuttall.)

Variation in form of wild nuts:

1. Ovate.
- 1a. Ovate, section of 1.
- 1b. Ovate, portion of hull of 1. Specimens from E. A. Prior, Akron, Ohio.
2. Long ovate, compressed.
- 2a. Long ovate, compressed, section of 2. Specimen from A. C. Harvey, Lafayette, Ind.
3. Quadrangular, compressed.
- 3a. Quadrangular, compressed, section of 3. Specimen from William Prior, Cuyahoga Falls, Ohio.
4. Obovate.
- 4a. Obovate, section of 4. Specimen from A. J. Coe, Meriden, Conn.

Named varieties:

5. Shinar.
- 5a. Shinar, section of 5. Specimen from Samuel C. Moon, Morrisville, Pa.
6. Meriden.
- 6a. Meriden, section of 6. Specimen from A. J. Coe, Meriden, Conn.
7. Jackson.
- 7a. Jackson, section of 7. Specimen from J. F. Rice, Berlin Cross Roads, Ohio.
8. Milford.
- 8a. Milford, section of 8. Specimen from O. C. Cook, Milford, Mass.
9. Rice.
- 9a. Rice, section of 9. Specimen from J. F. Rice, Berlin Cross Roads, Ohio.
10. Woodbourne.
- 10a. Woodbourne, section of 10. Specimen from Samuel C. Moon, Morrisville, Pa.



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SHAGBARK.
(*Hicoria ovata*, Britton.)
(Syn. *Carya alba*, Nuttall.)

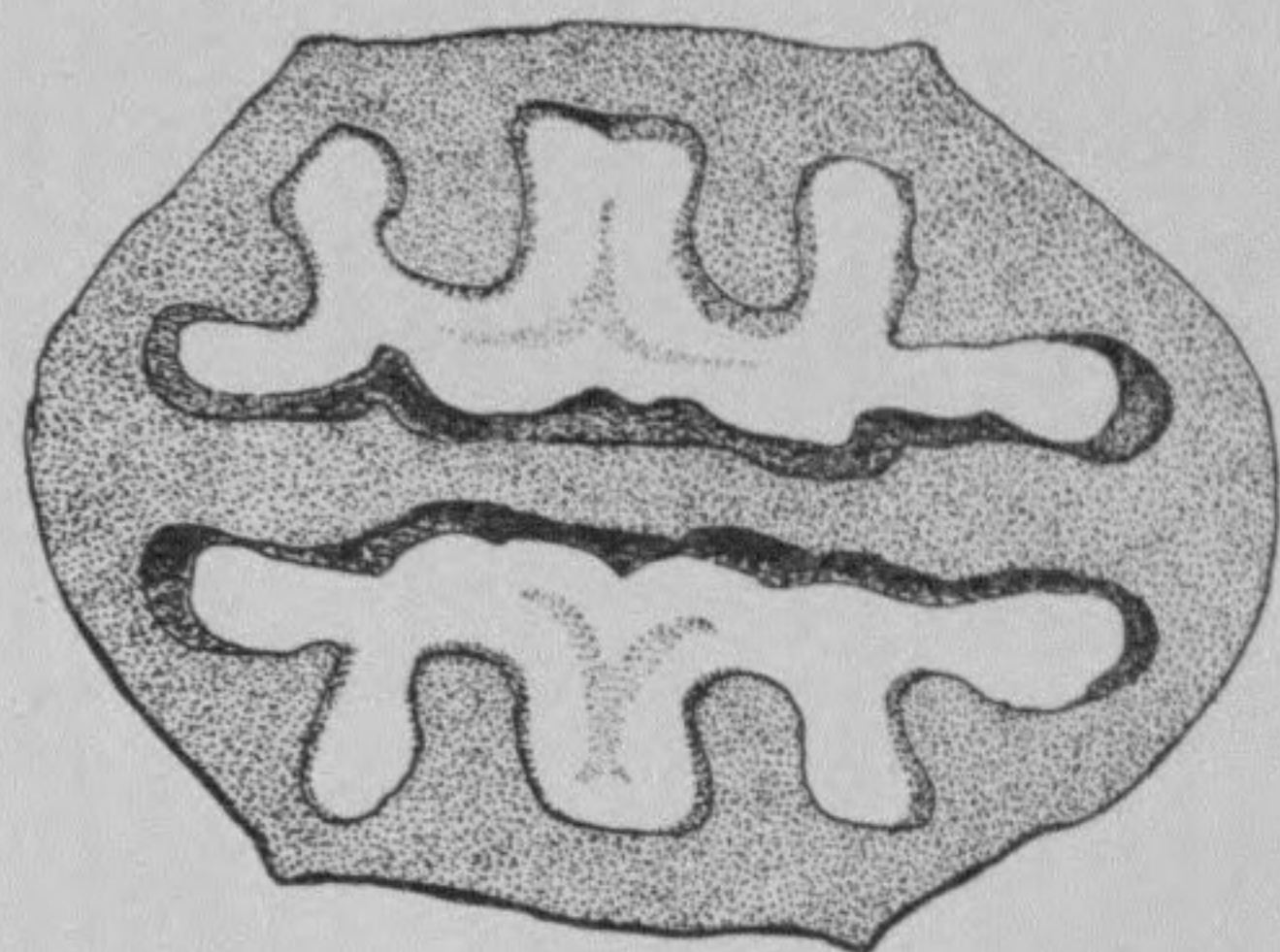
PLATE 11.

SHELLBARK.

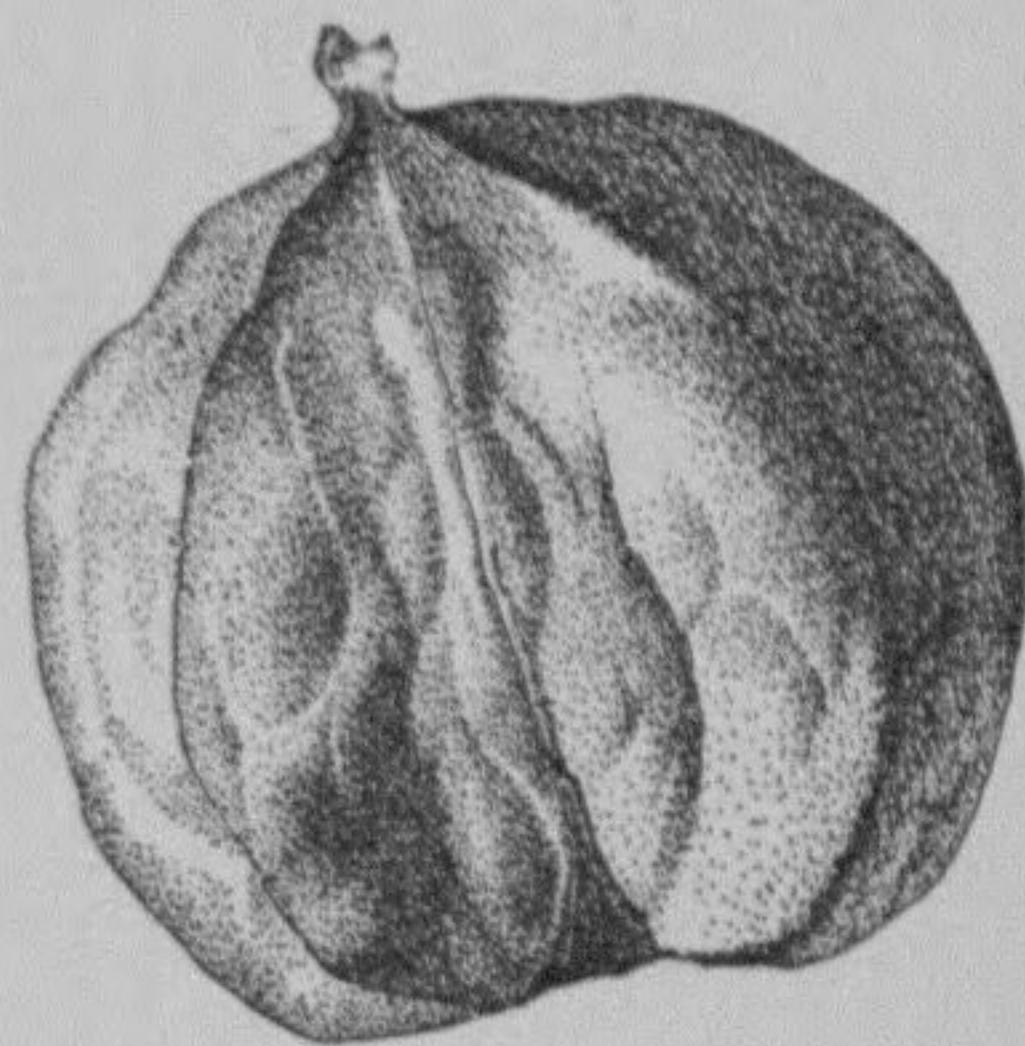
(*Hicoria laciniosa* Sargent. Synonym: *Carya sulcata* Nuttall.)

Variation in form of wild nuts.

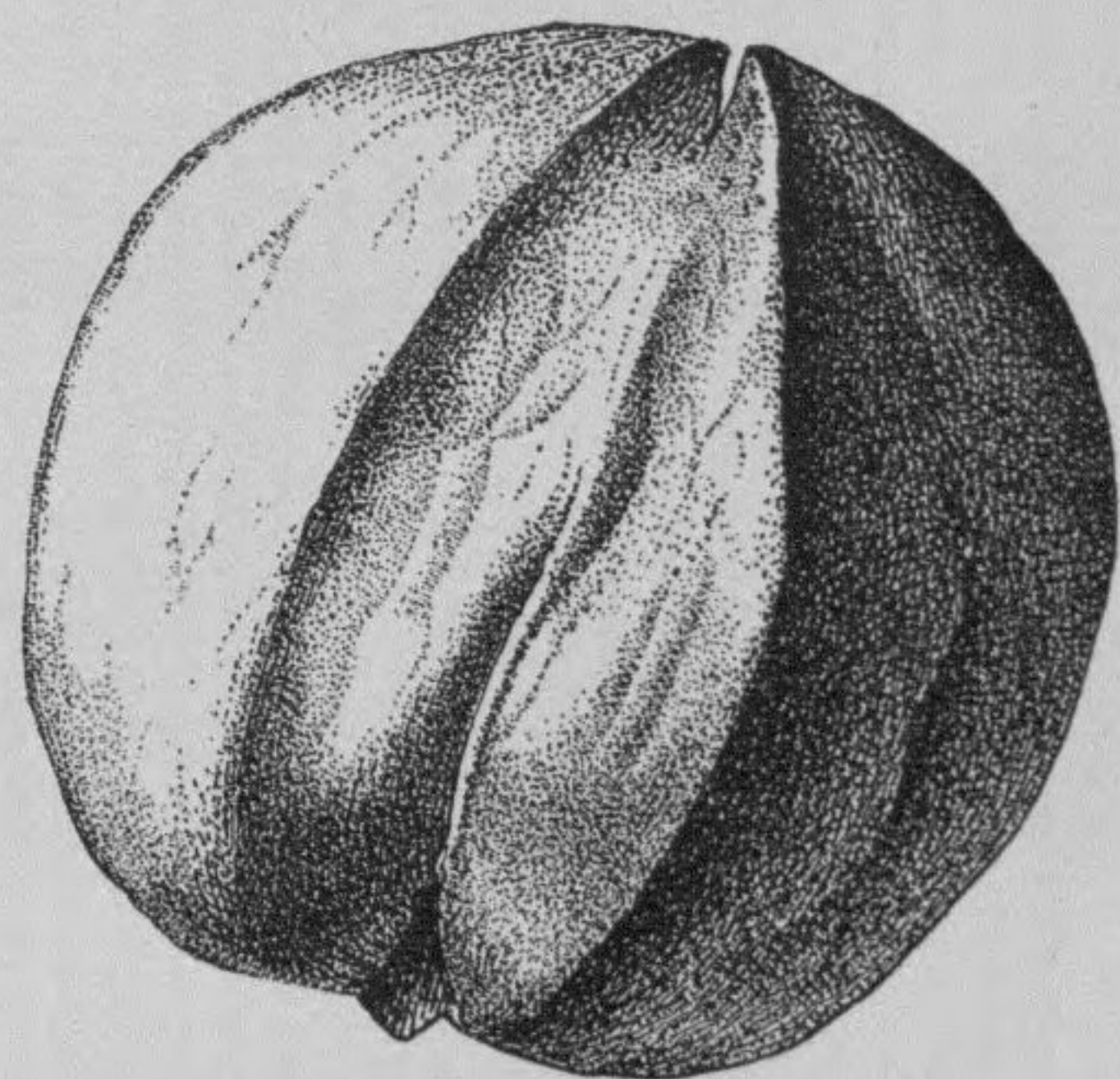
1. Quadrangular.
- 1a. Quadrangular, section of 1. Specimen from Peter Dailing, Boring, Tenn.
2. Roundish, compressed.
- 2a. Roundish, compressed, section of 2.
- 2b. Roundish, compressed, portion of hull of 2. Specimens from W. D. Hills, Odin, Ill.
3. Oval.
- 3a. Oval, section of 3. Specimen from Peter Dailing, Boring, Tenn.
4. Long ovate, compressed.
- 4a. Long ovate, compressed, section of 4.
5. Roundish, oblique.
- 5a. Roundish, oblique, section of 5.
Specimens of 4 and 5 from W. D. Hills, Odin, Ill.
6. Ovate, oblique.
- 6a. Ovate, oblique, section of 6. Specimen from Fred Lionberger, Hugo, Mo.



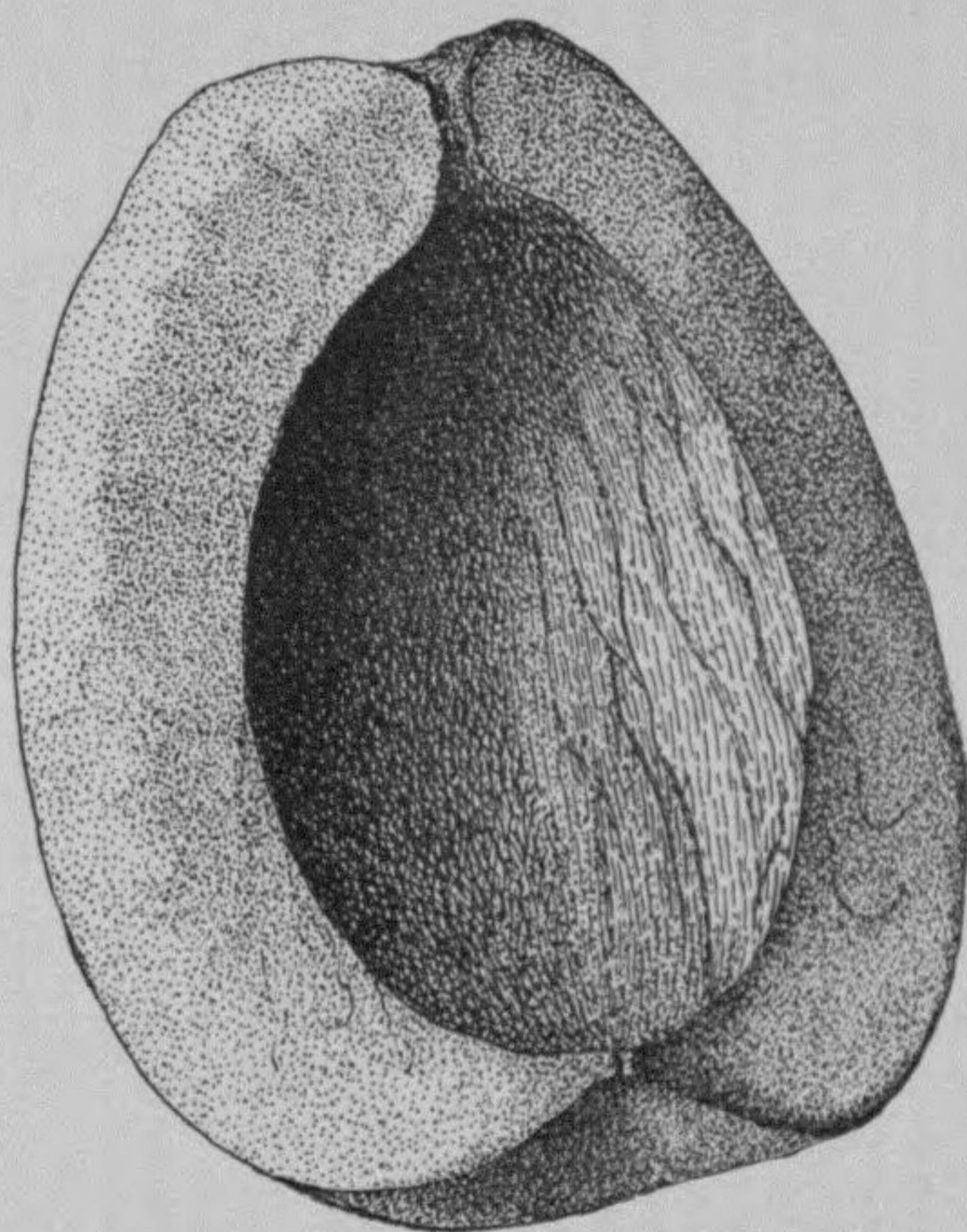
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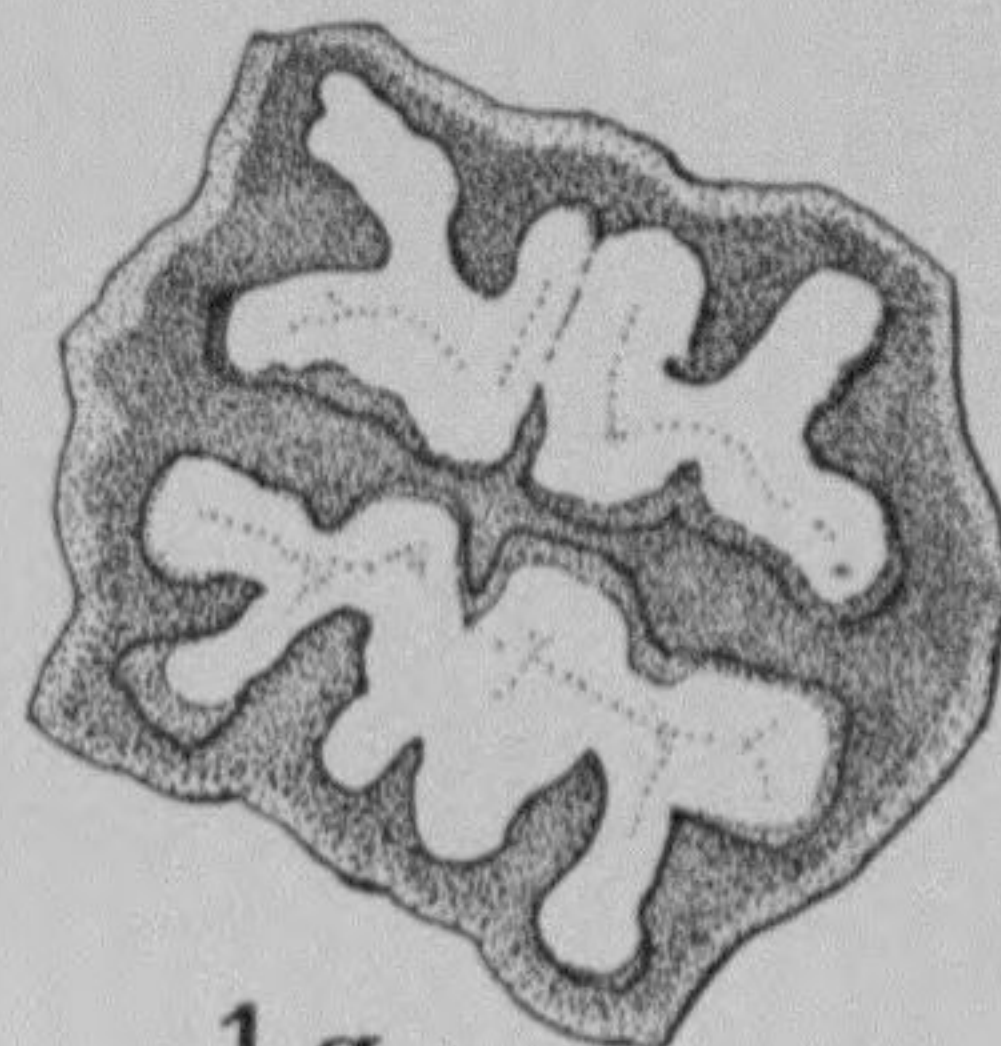
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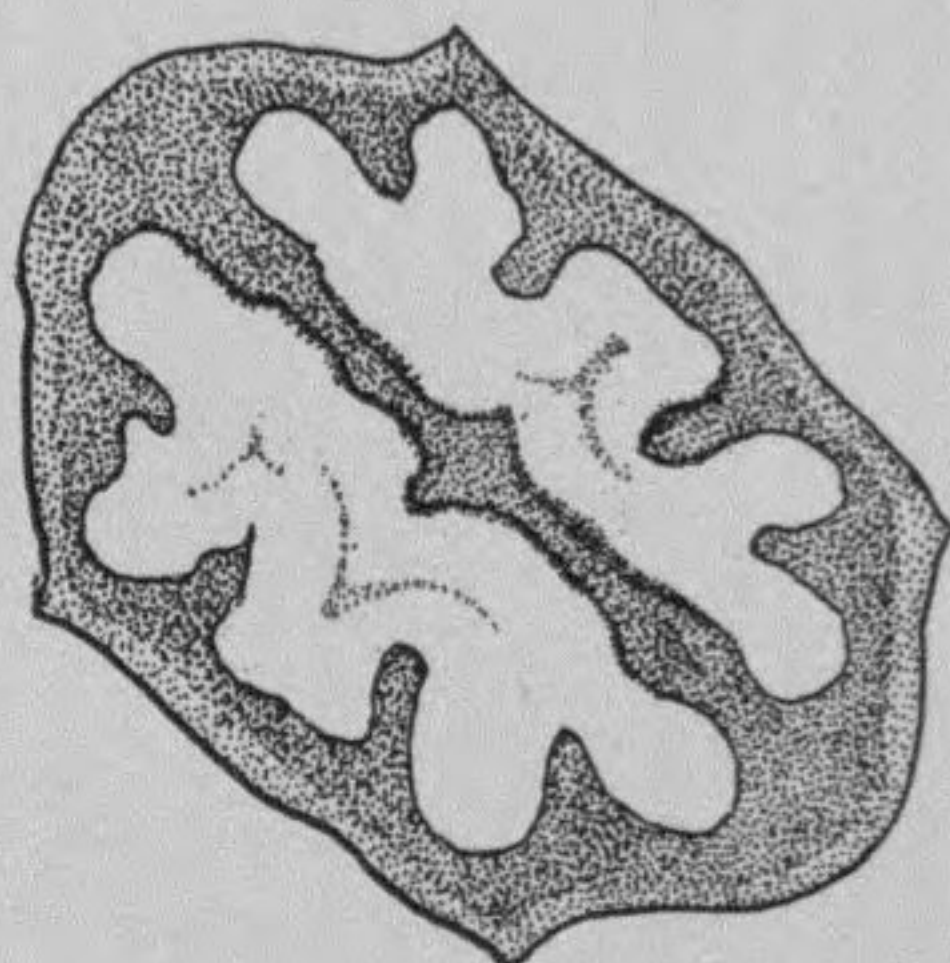
2



2 b



1 α



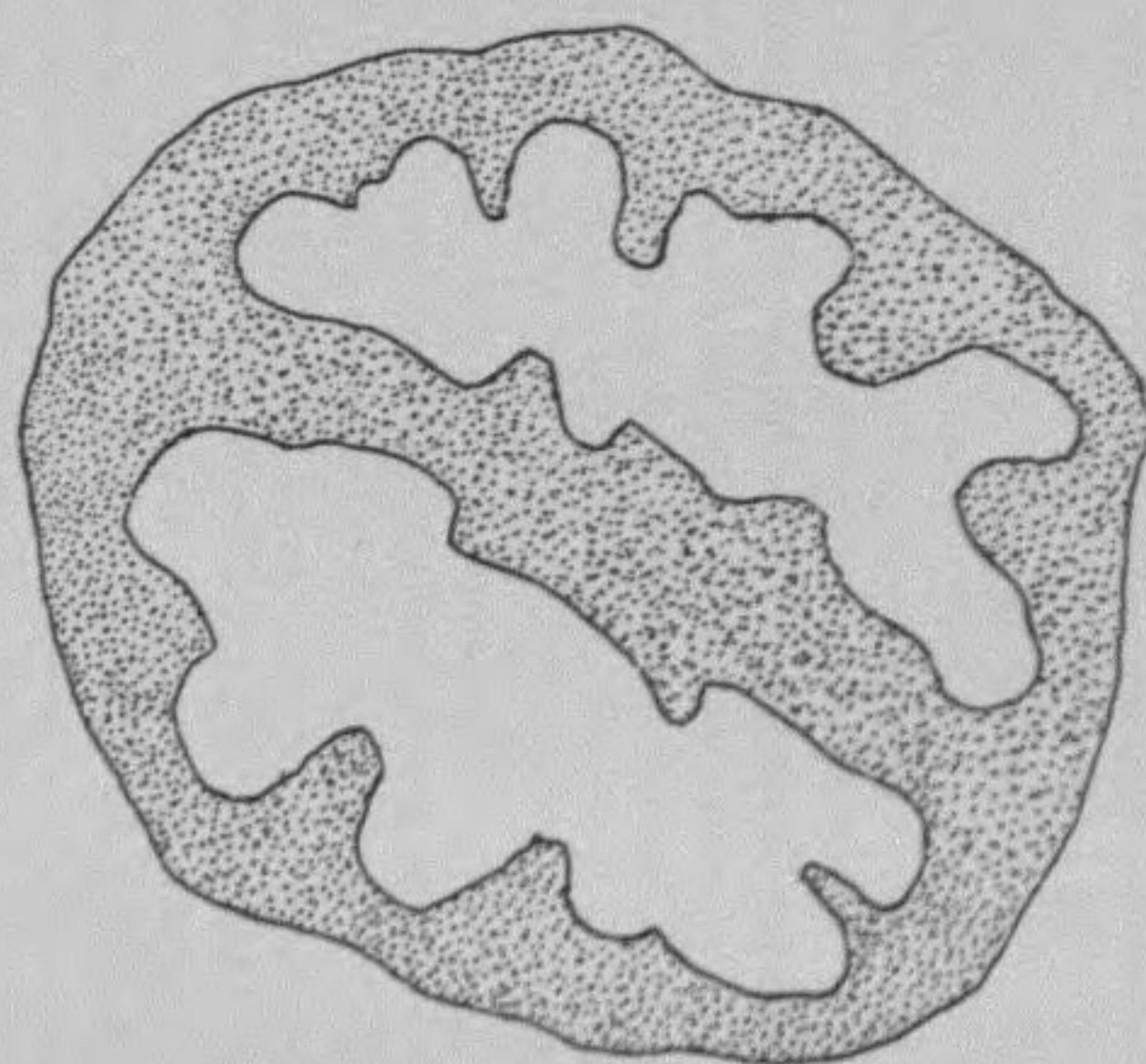
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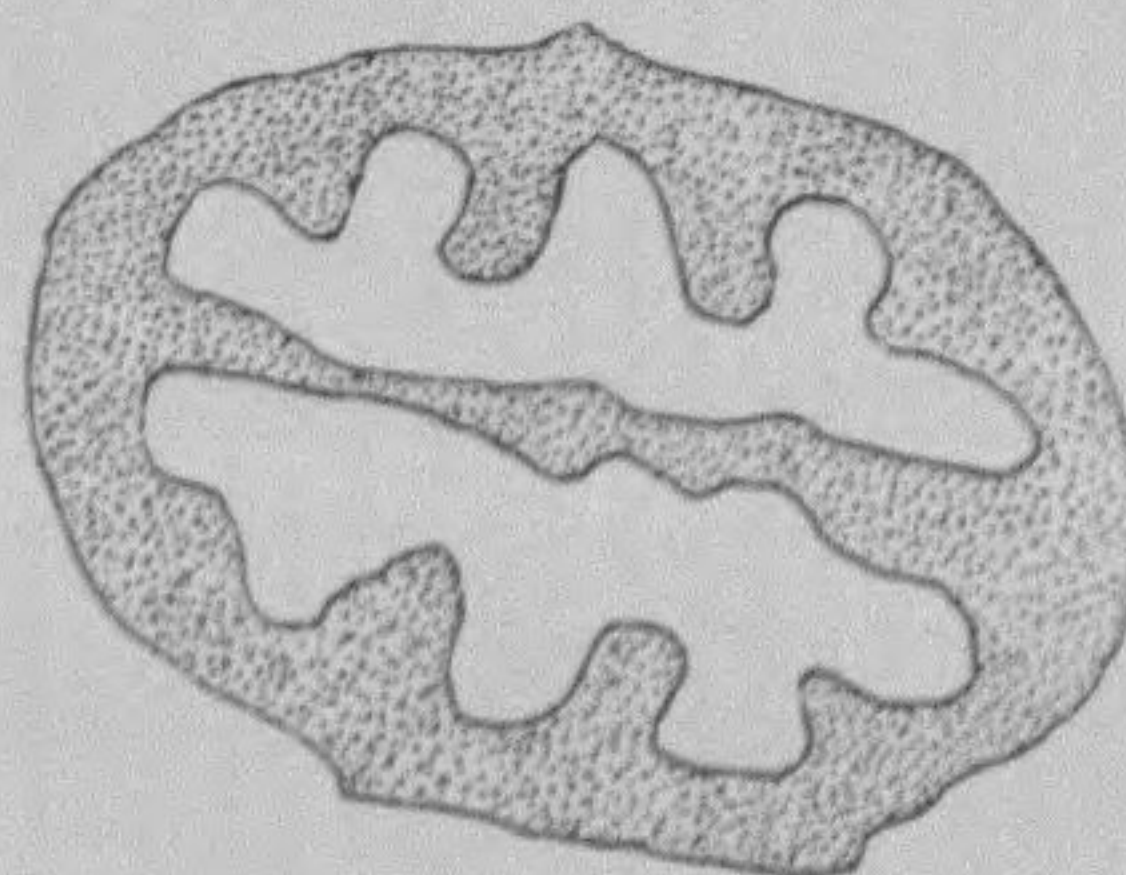
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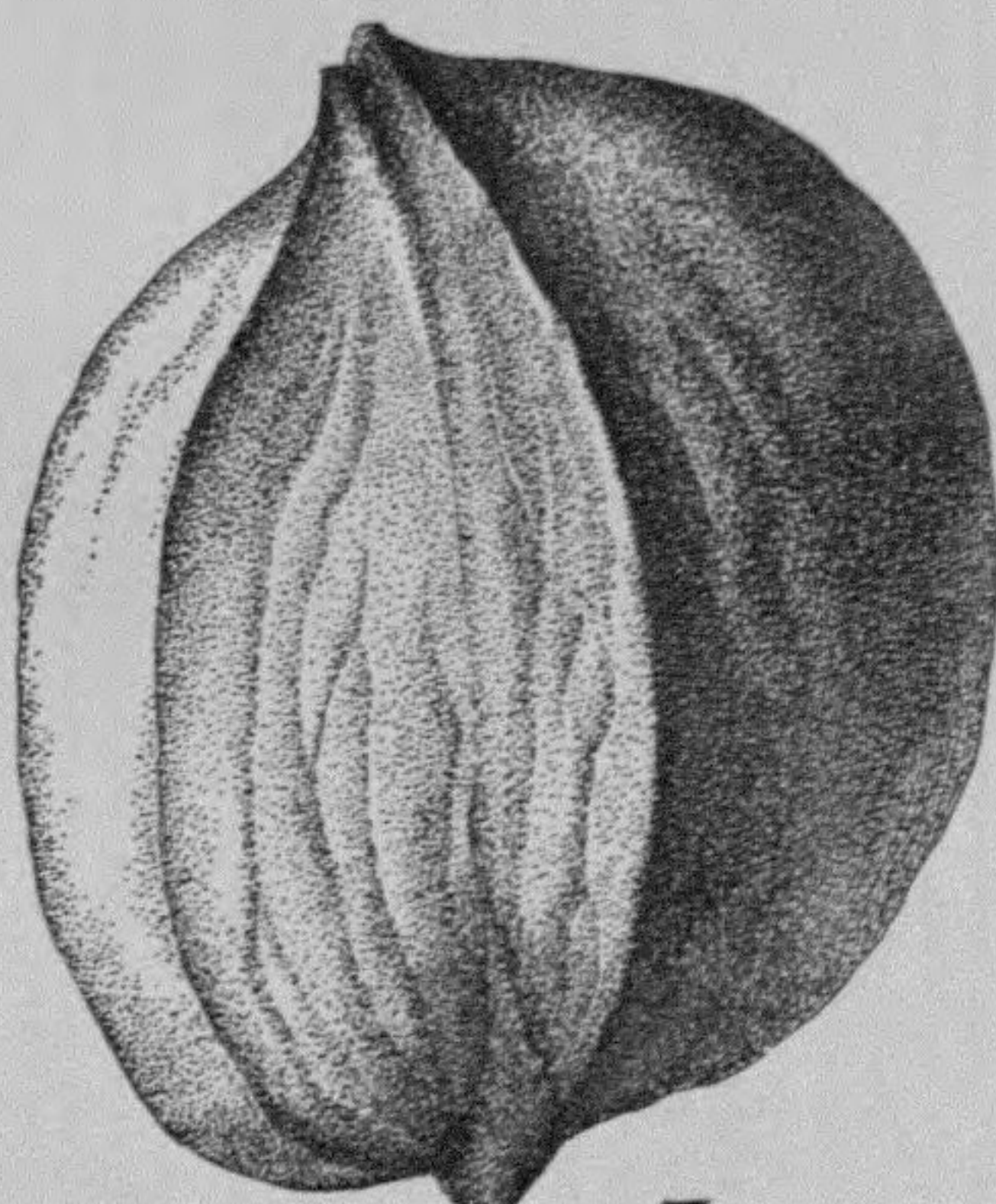
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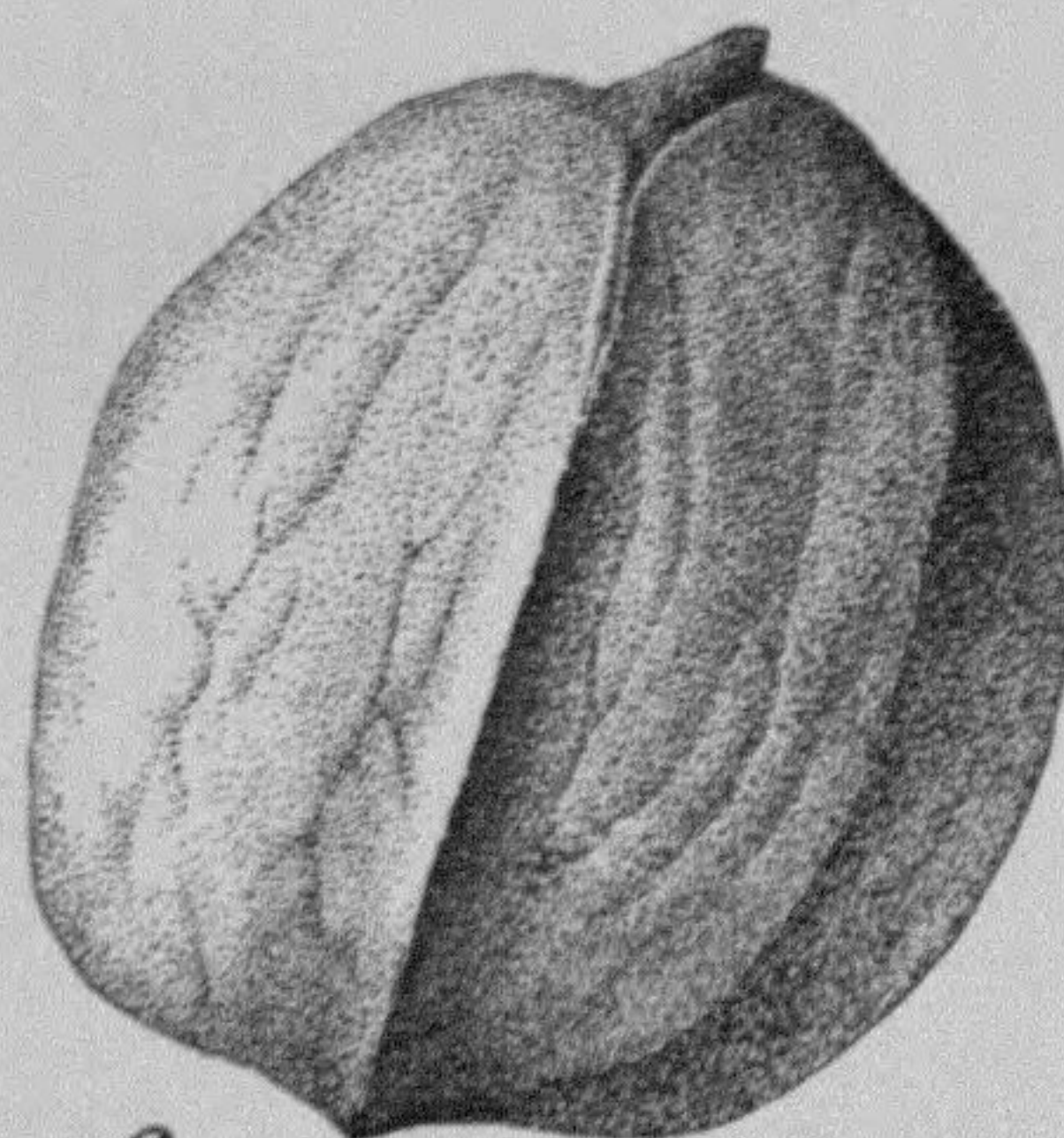
5 α



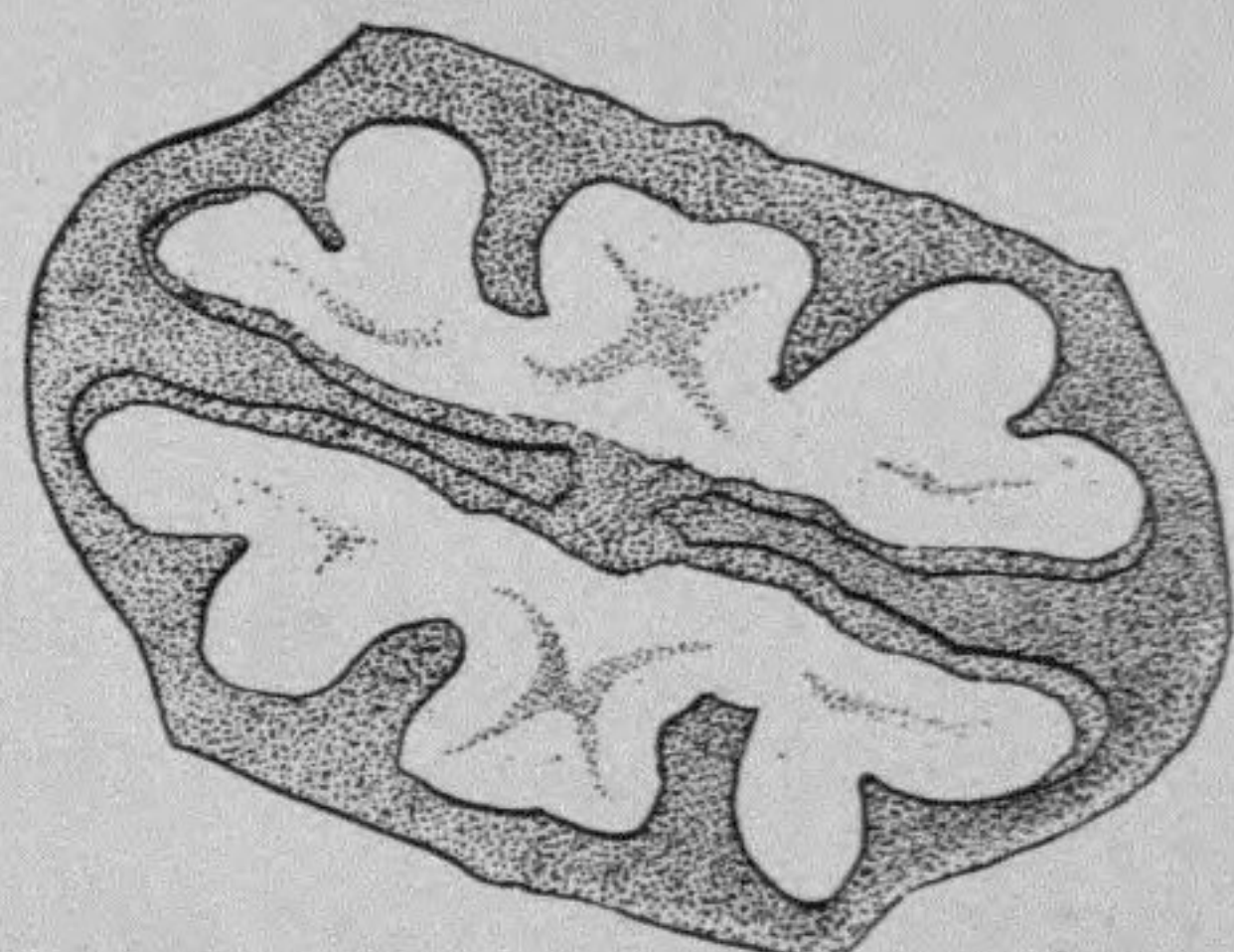
6 α



5



6



4 α

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SHELLBARK.

(*Hicoria laciniosa*, Sargent.)
(Syn. *Carya sulcata*, Nuttall.)

PLATE 12.

MISCELLANEOUS HICKORIES.

Mocker nut. *Hicoria alba* Britton. Synonym: *Carya tomentosa* Nuttall.

Variation in form of wild nuts:

1. Oval.
- 1a. Oval, section of 1.
2. Roundish.
- 2a. Roundish, section of 2.

Specimens of 1 and 2 from J. N. Harris, Griffin, Ga.

3. Roundish, oblique.
- 3a. Roundish, oblique, section of 3.
- 3b. Roundish, oblique, portion of hull of 3. Specimens from Albert Fries, St. Nicholas, Fla.

Pig nut. (*Hicoria glabra* Britton. Synonym: *Carya porcina* Nuttall.)

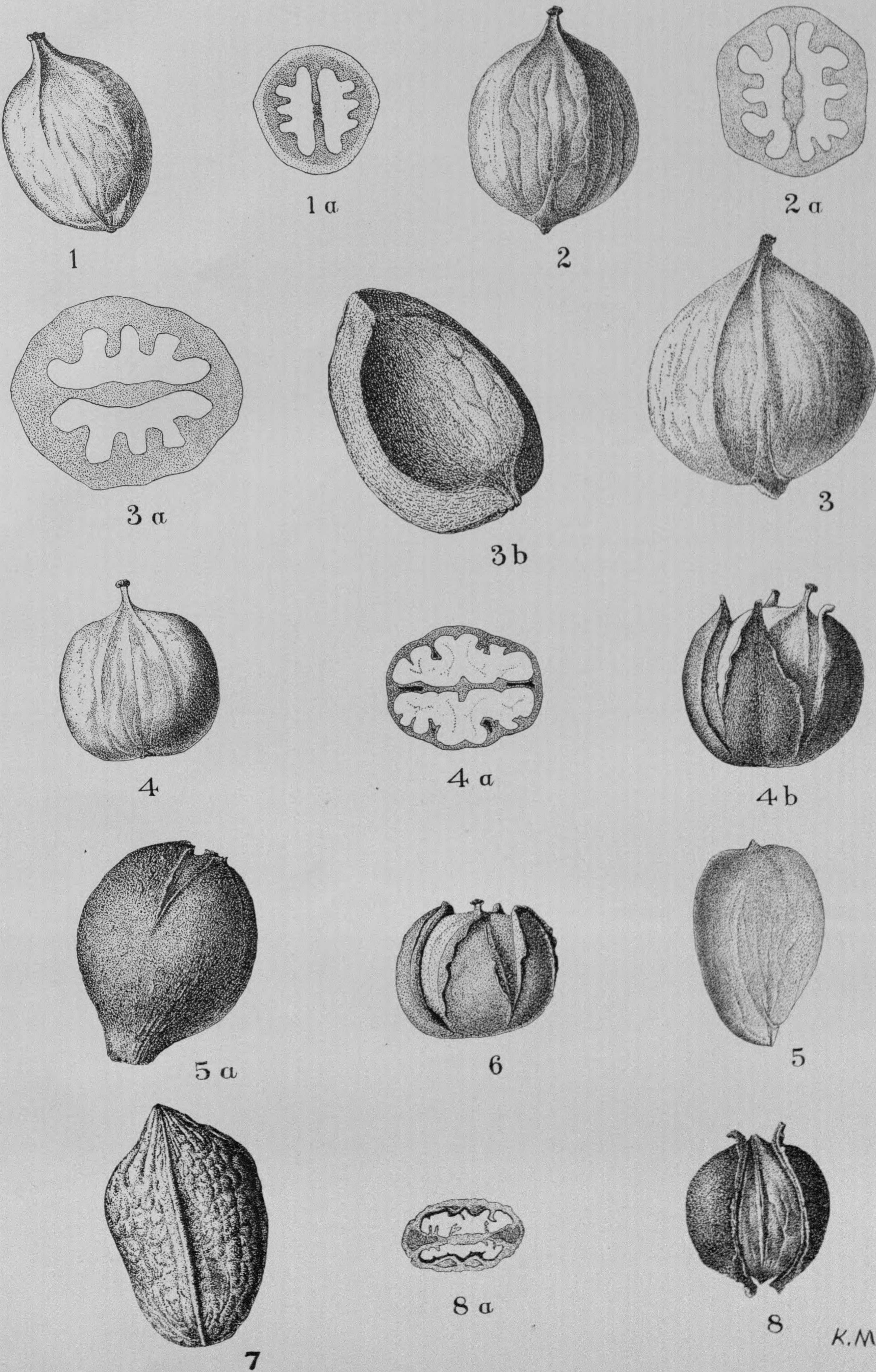
4. Brackett.
- 4a. Brackett, section of 4.
- 4b. Brackett, nut of 4 in hull. Specimens from G. B. Brackett, Denmark, Iowa.
5. Fig-shaped.
- 5a. Fig-shaped, nut of 5 in hull. Specimens grown in Maryland; furnished by Samuel J. Wallace, Washington, D. C.
6. Roundish nut in hull. Specimen from George Rumler, Mohawk, Ind.

Undetermined hickory, possibly *Hicoria Texana* Le Conte.

7. Specimens from the late W. R. Stuart, Ocean Springs, Miss., who received them from Texas.

Water hickory. (*Hicoria aquatica* Britton. Synonym: *Carya aquatica* Nuttall.)

8. Nut and portion of hull.
- 8a. Section of nut. Specimens from Vernon H. Harris, Micco Fla.



K. Mayo del

PLATE 13.

MISCELLANEOUS HAZELS.

European hazels; cultivated forms derived from *Corylus avellana* L. and *Corylus tubulosa* Willd.

1. Imported nut, bought of dealer in Washington, D. C.
2. Specimen grown by E. Wardroper, Pelee Island, Canada.
3. "Istrian," an imported nut, bought of dealer in Washington, D. C.
4. Specimen grown by Robert Manning, Salem, Mass.
5. Seedling, grown by Josiah Prettyman, Smith, Del.
- 5a. Seedling, portion of twig showing winter buds of 5.
- 5a'. Seedling, dormant pistillate buds.
- 5a''. Seedling, dormant staminate catkins.
6. Specimen grown by W. D. Brackenridge, Govanstown, Md.
7. Specimen grown by George W. Sutton, Perryville, Md.

Native hazels.

American hazel. (*Corylus Americana* Michx.)

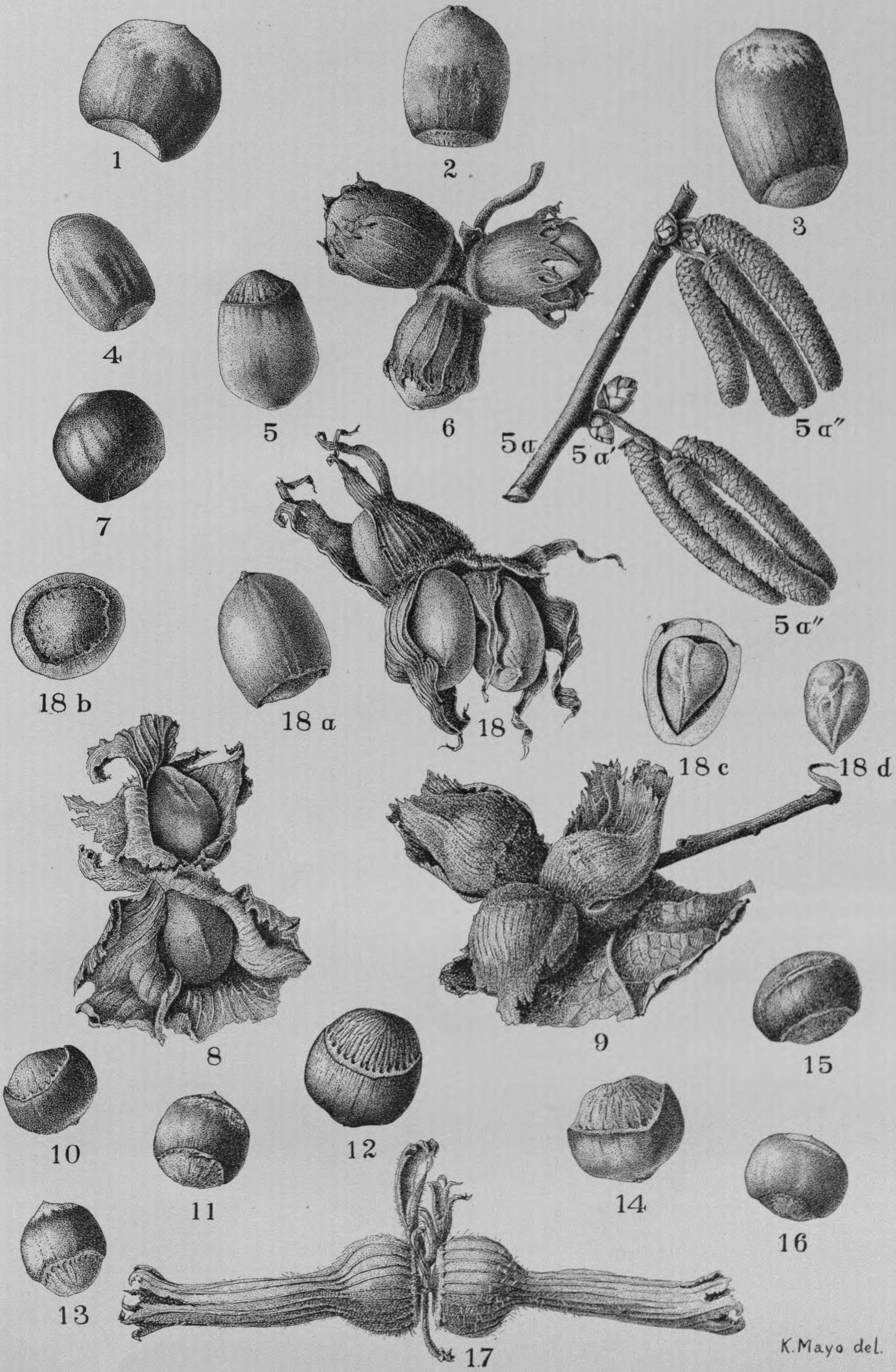
8. Form with open involucre. Specimens from A. W. Hoffman, Peculiar, Mo.
 9. Form with closed involucre. Specimens from G. C. Betts, Fancher, Ohio.
 - 10.)
 - 11.)
 - 12.)
 - 13.)
 - 14.)
 - 15.)
 - 16.)
- Varying forms and sizes. Specimens from R. C. Hall, Canajoharie, N. Y.
- Varying forms and sizes. Specimens from J. C. Chilton, Otto, Tenn.

Beaked hazel. (*Corylus rostrata* Aiton.)

17. Typical cluster. Specimens from E. S. Lane, Belchertown, Mass.

California hazel. (*Corylus Californica* Rose.)

18. Cluster showing normal and abnormal fruiting habit.
- 18a. Side view of nut.
- 18b. Basal view of nut.
- 18c. Longitudinal section of shell showing kernel.
- 18d. Reverse view of kernel. Specimens from T. J. May, Mount Vernon, Wash.



K. Mayo del.

PLATE 14.

MISCELLANEOUS CHESTNUTS.

American chestnut. (*Castanea dentata* Sudworth.)

1. A small, wild form. Specimen from F. L. Hartford, Sterling, Pa.
2. Murrell. Specimen from George E. Murrell, Colemans Falls, Va.
3. Hulse. Specimen from Wells Hulse, Campbell Hall, N. Y.
4. Excelsior. Specimen from James E. Kendall, Gazil, W. Va.
5. Ketcham. Specimen from J. R. Hawkins, Mountainville, N. Y.
6. Wild form, from tree that yields abundantly. Specimen from Shirley Tappan, Jericho, N. Y.
7. Watson. Specimen from R. B. Clark, Fay, Pa.
8. Otto. Specimen from J. C. Chilton, Otto, Tenn.
9. Dulaney. Specimen from William L. Dulaney, Bowling Green, Ky.
10. Griffin. Specimen from J. N. Harris, Griffin, Ga.

European chestnut. (*Castanea sativa* Miller.)

11. Numbo. Specimen from Samuel C. Moon, Morrisville, Pa.
12. Ridgely. Specimen from P. Emerson, Wyoming, Del.

Japanese chestnut. (*Castanea Japonica* Blume.)

13. Japan Giant. Specimen from William Parry, Parry, N. J.

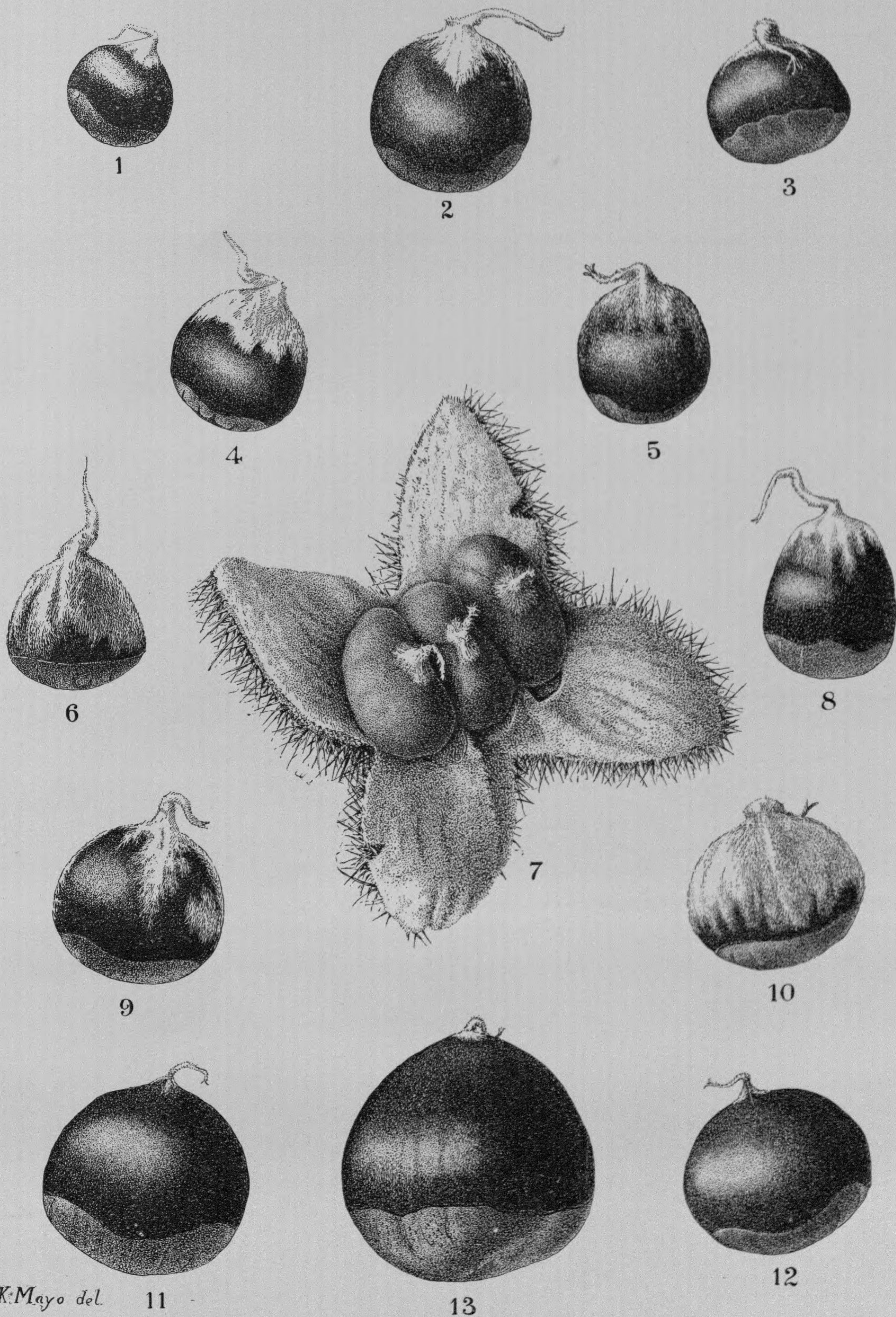


PLATE 15.

WESTERN CHINKAPIN—CHINKAPIN—BEECH.

Western Chinkapin. (*Castanopsis crysophylla* A. D. C.)

1. Fruiting cluster.
2. Leaves. Specimens from E. C. Russell, Sweet Home, Oreg.

Chinkapin. (*Castanea pumila* Miller.)

3. Common form of fruiting cluster.
- 3a. Nut of 3.
- 3b. Nut of 3.

Specimens from George W. Johnson, Manassas, Va.

4. Spiked form of fruiting cluster.
- 4a. Nut of same.
- 4b. Nut of same.

Specimens from Forestry Division, United States Department of Agriculture.

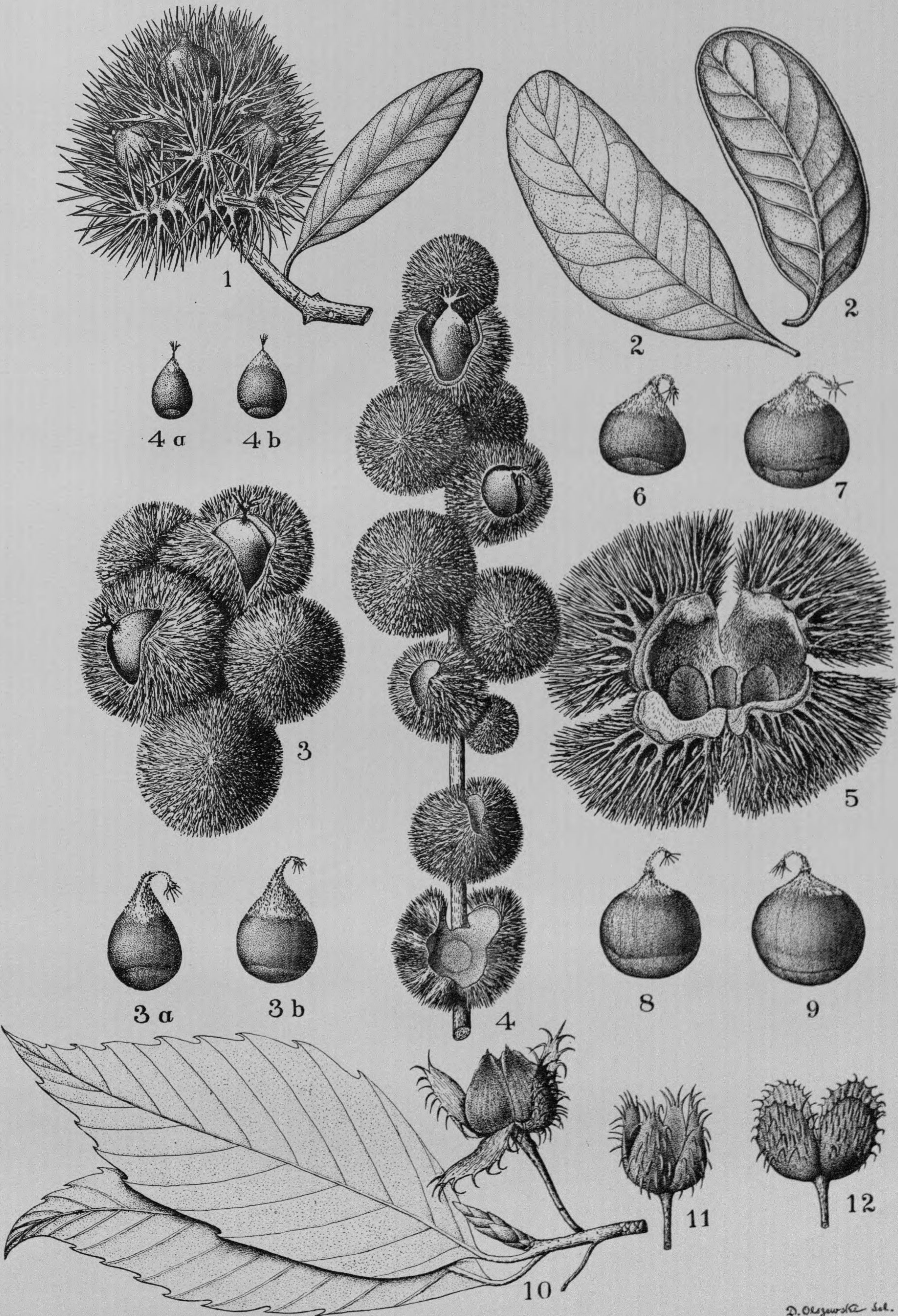
5. Tree chinkapin bur.
- 6, 7. Tree chinkapin nuts of 5.

Specimens from J. O. Grimsley, Otto, Tenn.

- 8, 9. Tree chinkapin nuts. Specimens from George E. Murrell, Colemans Falls, Va.

Beech. (*Fagus atropunicea* Sudworth. Synonym: *Fagus ferruginea* Aiton.)

10. Twig, leaf, bur, and nuts. Specimens from Addis E. Green, Walled Lake, Mich.
11. Bur. Specimen from Smithsonian Grounds.
12. Bur. Specimen from William G. Voorheis, South Frankfort, Mich.



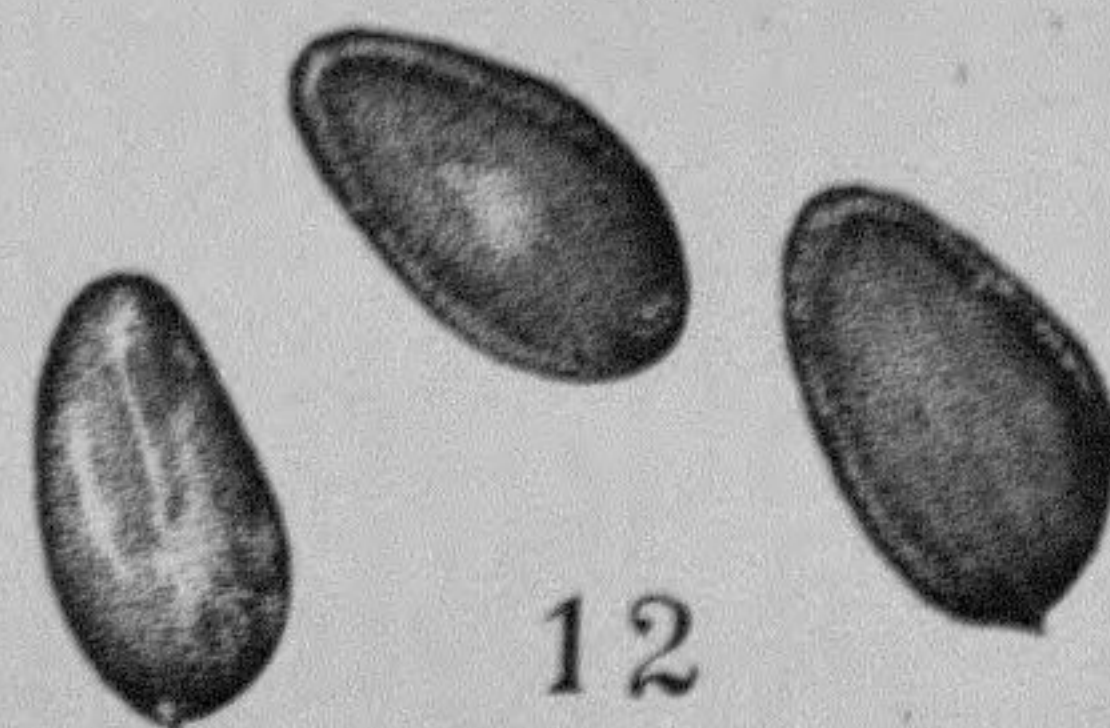
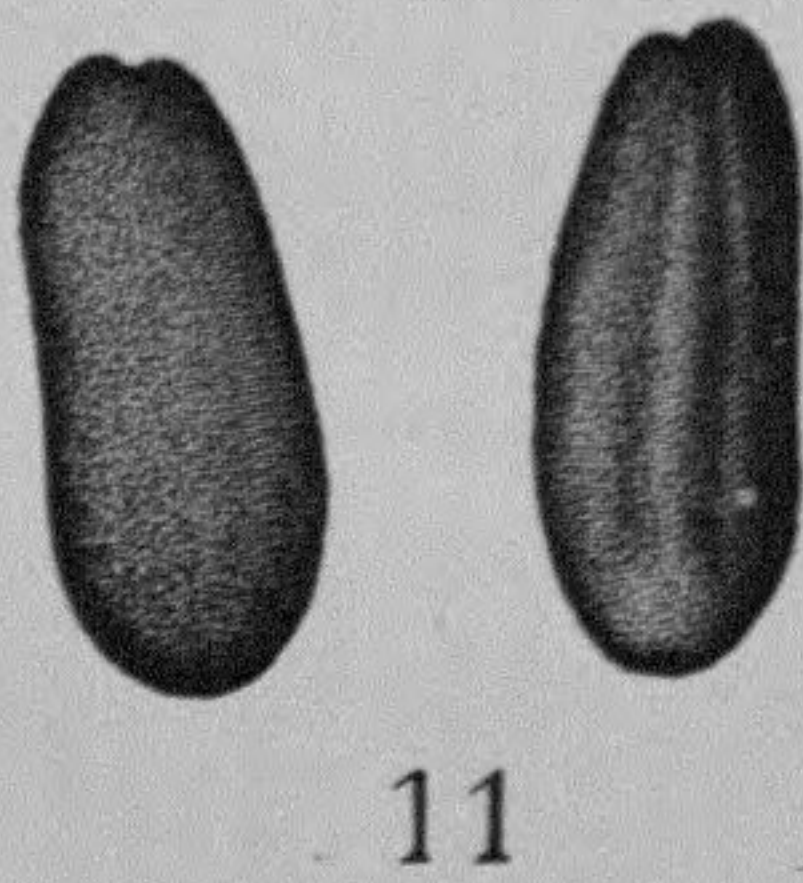
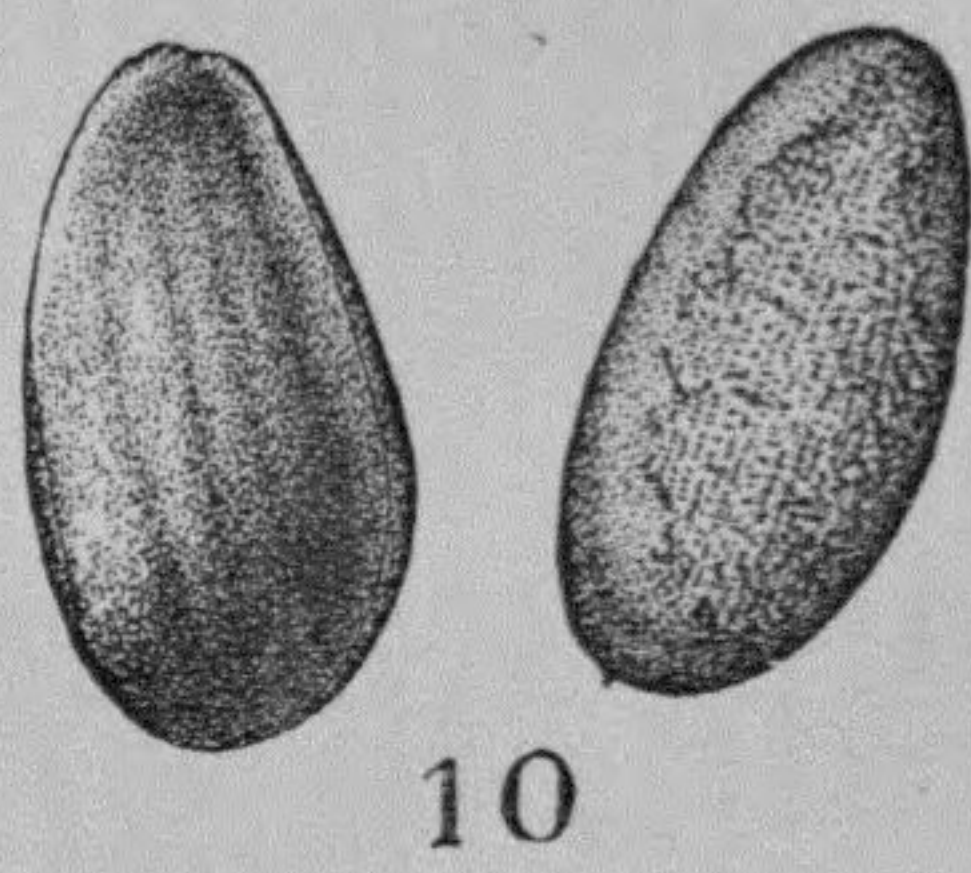
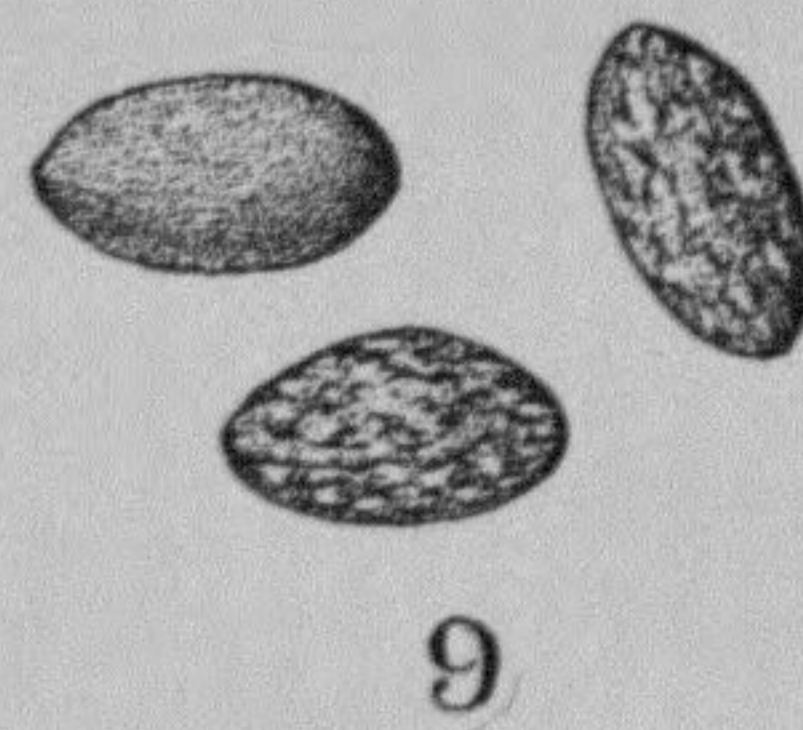
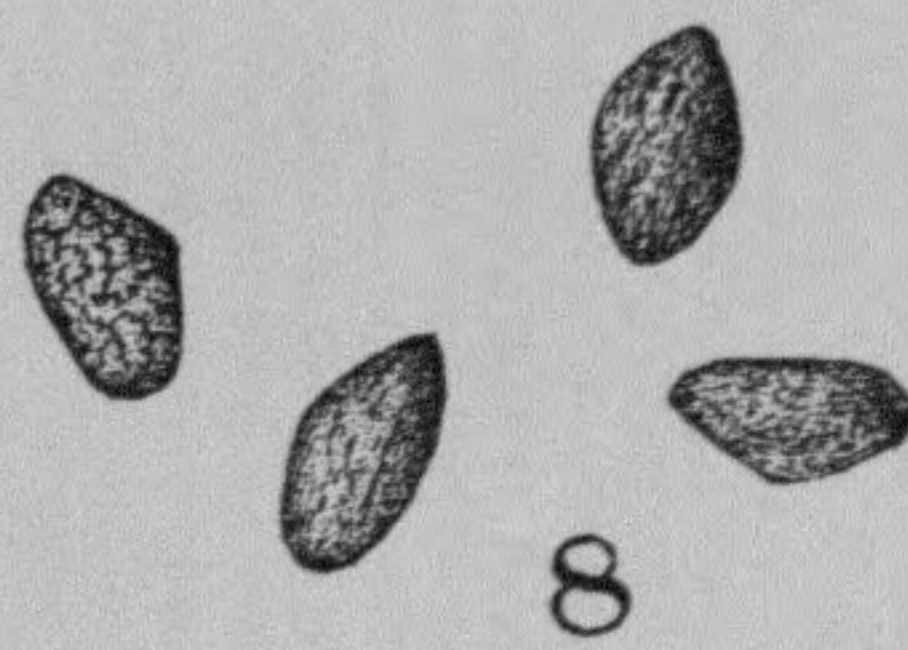
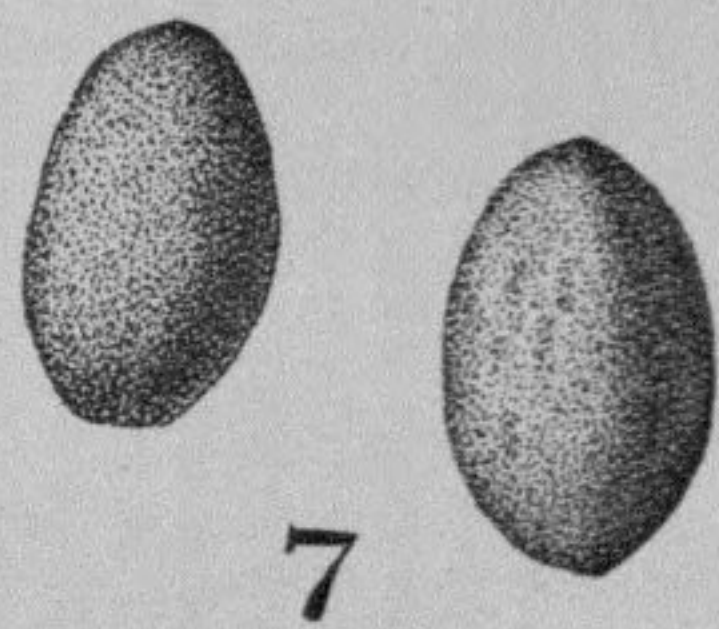
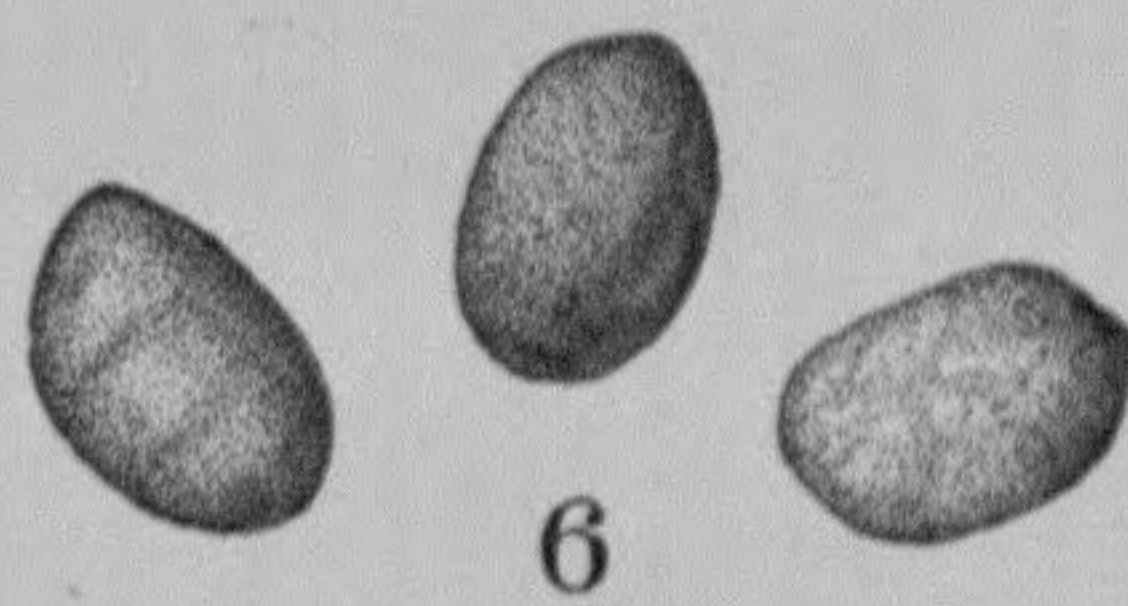
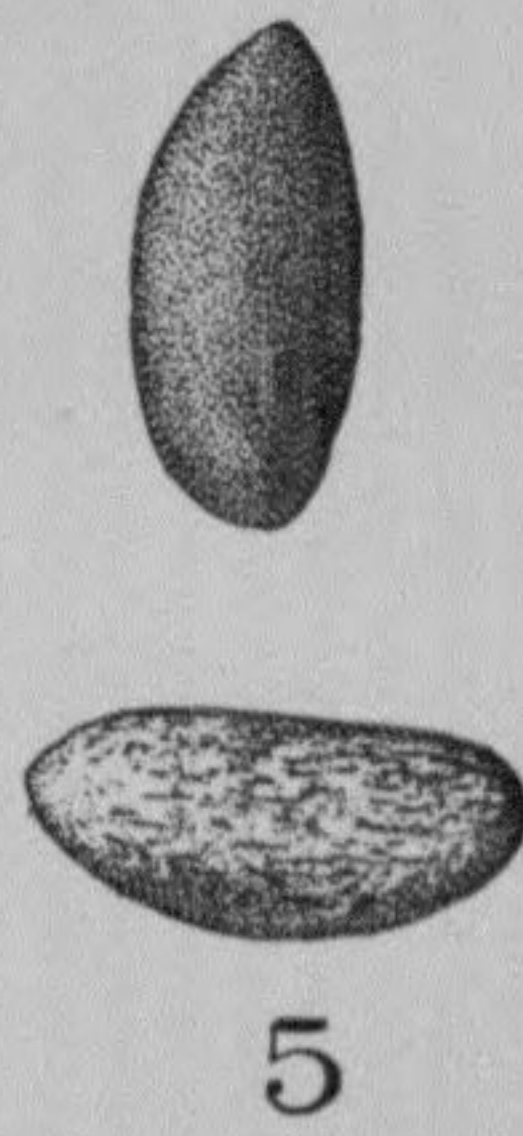
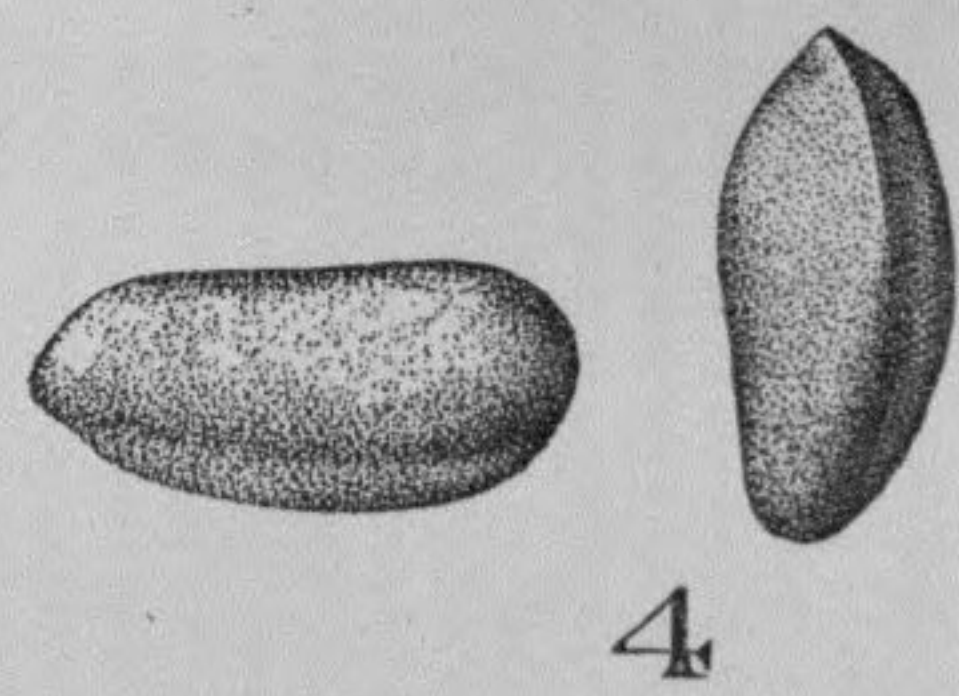
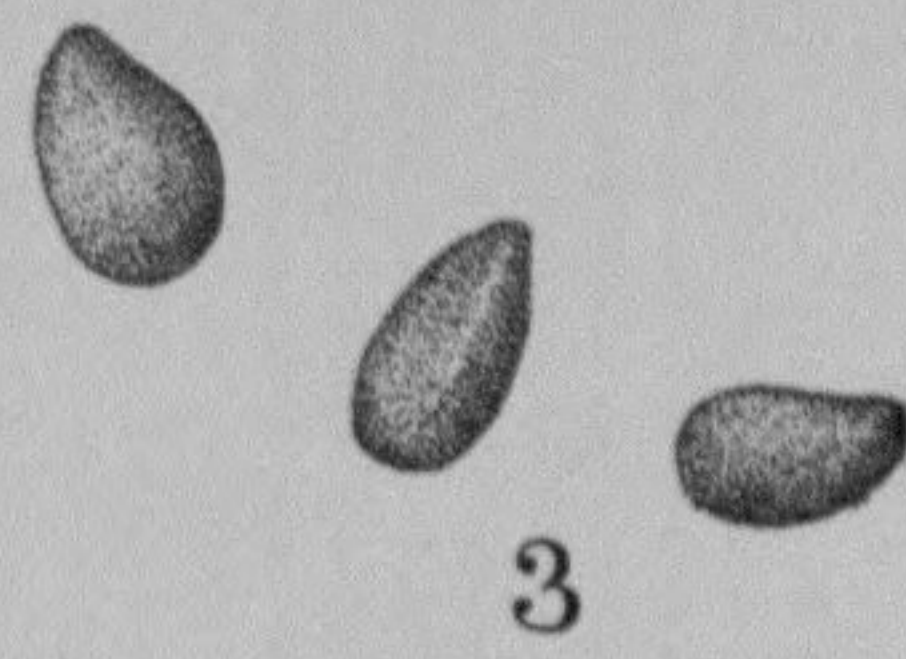
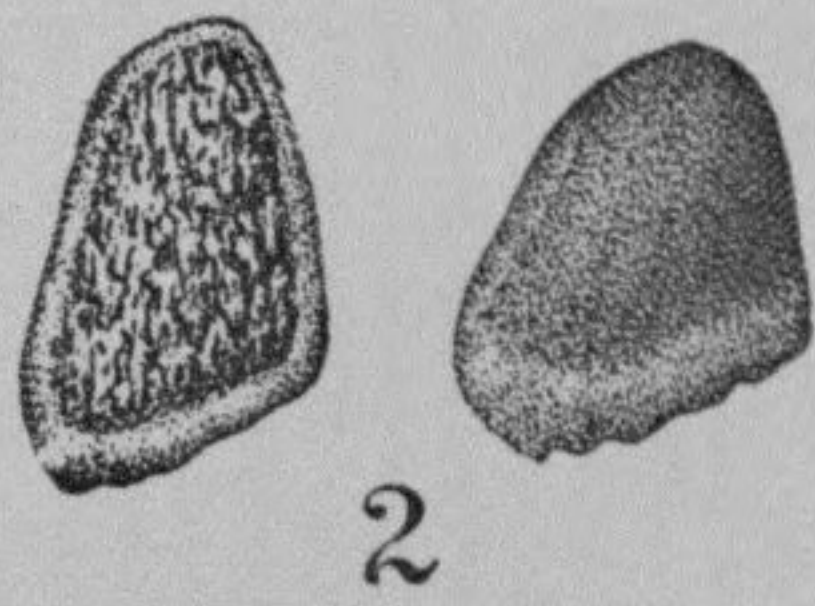
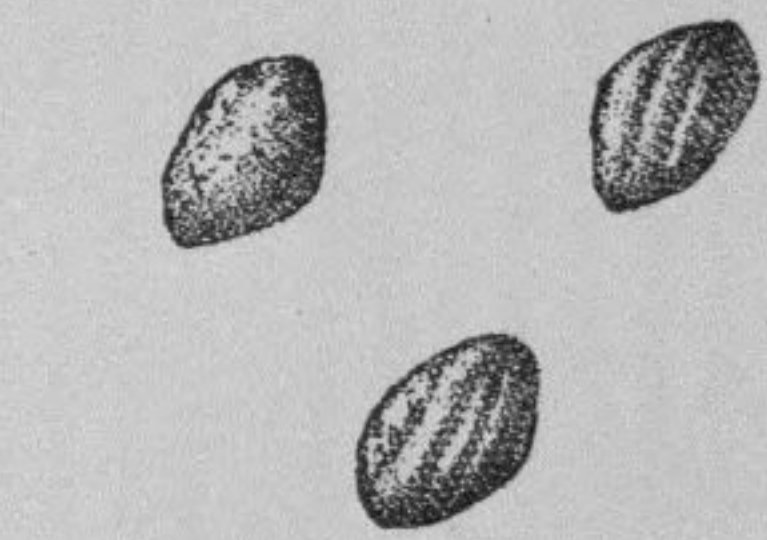
D. Olszewski del.

PLATE 16.

MISCELLANEOUS PINES.

1. Mountain pine. (*Pinus monticola* Doug.)
2. Sugar pine. (*Pinus lambertiana* Doug.)
3. White-bark pine. (*Pinus albicaulis* Engel.)
4. Single-leaf pine. (*Pinus monophylla* Tor. & Frem.)
5. Parry pine. (*Pinus parryana* Engel.) Synonym: *Mexican piñon*.
6. Piñon. (*Pinus edulis* Engel.)
7. Arizona pine. (*Pinus cembroides* Zucc.)
8. Yellow pine. (*Pinus ponderosa* Doug.) Synonym: *Heavy pine*.
9. Black pine. (*Pinus jeffreyi* Mur.)
10. Torrey pine. (*Pinus torreyana* Parry.)
11. Gray-leaf pine. (*Pinus sabiniana* Doug.)
12. Big-cone pine. (*Pinus coulteri* Don.)

Specimens of all the above pines, together with much valuable information, received from
J. G. Lemmon, Oakland, Cal.



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Heiges, S. B.

Nut Culture in the United States U. S. Department of Agriculture. Division
of Pomology. Embracing native and introduced Species

Washington 1896

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